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URBAN HIGHWAY DESIGN GUIDE

DEPARTMENT OF HIGHWAYS AND TRANSPORT
PROVINCE OF ALBERTA

Hon. Clarence Copithorne
Minister

L.H. McMANUS
Deputy Minister

* 22.50

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ALBERTA, CANADA.

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PLANNING BRANCH - HIGHWAYS BUILDING,
97 AVENUE AND 106 STREET,
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ALBERTA, CANADA.

FOREWORD

This Manual represents the result of work by a Technical Committee in assembling, simplifying and producing geometric design standards, contract drawings, and specifications adapted to fit local needs and conditions, and to serve as a general guide on those projects which qualify for Provincial assistance under the current Five Year and anticipated subsequent Program of Grants to Cities for Streets and Structures.

Soon after the start of the current Program in 1966 it became apparent to those responsible, for the production and administration of the work, that guide lines should be established to standardize the design and drafting criteria in order that design standards and contract documents would be of a uniform nature, regardless of the agency actually performing the work.

It was considered that standardization of as much of the work as possible would produce the following benefits:

(A) Design Criteria
Simplify for the most part the difficulties encountered by Design Engineers in the selection of proper highway standards for each highway classification.

(B) Drafting Criteria
The use of a detailed geometrics and drafting standard guide that would
(1) Produce uniform contract documents
(2) Standardize construction techniques
(3) Allow for more efficient bidding

(C) Administration

Assist the administrations involved in the checking of plans, specifications, and agreement procedures.

An Agreement covering the preparation of this Manual was entered into between the Province of Alberta, the City of Calgary and the City of Edmonton. The firm of De Leuw Cather & Company of Canada Limited was engaged to compile, research and prepare the material under the guidance and direction of a Technical Committee made up of representatives of the above mentioned agencies.

The general philosophy as envisaged by the Committee was one in which the design criteria should not be regarded as absolute but rather one of guidance. It should be noted that no attempt has been made to cover all aspects of Geometric Design and it was therefore assumed, in the preparation of this Manual, that the reader would be fully conversant with AASHO and CGRA Design Criteria. In some cases, (primarily entrance and exit ramp terminal design to which considerable attention was given and research undertaken) the Manual specifies significantly higher standards than those of AASHO - "A Policy of Geometric Design of Rural Highways, 1965" and of CGRA - "Geometric Design Standards For Canadian Roads and Streets, 1963". This does not imply that the standards contained in these publications are invalid but, it is recommended where differences occur between this Manual, AASHO, and CGRA, the designer should make every attempt to achieve the higher standards.

Aesthetics, not only of the highway but also of the road itself as viewed by both drivers and pedestrians, should be a prime consideration in the design of any highway facility. For this reason the first chapter of Part 1 has been devoted exclusively to a series of examples which illustrate some aspects of combined vertical and horizontal alignment to which the reader-designer should give careful consideration.

The Street Classifications used throughout, in accordance with CGRA, are as follows:

U C U - Urban Collector Undivided
U C D - Urban Collector Divided
U A U - Urban Arterial Undivided
U A D - Urban Arterial Divided
U F D - Urban Freeway Divided

This Manual consists of two basic parts, namely: Part 1 - Design Guides; Part 11 - Drafting Guides for Contract Drawings. It has been produced in loose-leaf form in order to incorporate any additions and/or revisions that may be made in the future. Illustrations both in the form of Figures and Exhibits have been utilized throughout this publication, with the former type dispersed throughout the text while exhibits are grouped together at the end of each chapter.

The Technical Committee

URBAN HIGHWAY DESIGN GUIDE

Technical Committee

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ACKNOWLEDGEMENTS

The Technical Committee wish to thank the coauthors, Mr. C. Tunnard and Mr. B. Pushkarev of "MAN MADE AMERICA: Chaos or Control?", Yale University Press and Prof. B. Smith and Mr. R. Fogo, coauthors of "Some Visual Aspects of Highway Design", Highway Research Record No. 172, Highway Research Board for permitting the reproduction of the photographs illustrated in Chapter A of this Manual.

Appreciation is also extended to the Highway Research Board for use of portions of Special Report 81, "Highway Guardrail".

Permission for the reproduction of various diagrams, tables and extracts from the American Association of State Highway Officials publication, "A POLICY on GEOMETRIC DESIGN of RURAL HIGHWAYS - 1965" and the Canadian Good Roads Association manual, "GEOMETRIC DESIGN STANDARDS FOR CANADIAN ROADS And STREETS", are also gratefully acknowledged.

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PART 1

DESIGN GUIDES

CHAPTER · A

AESTHETIC CONSIDERATIONS IN HIGHWAY DESIGN

The visual aspect of the highway as viewed by the motorist should definitely be considered as one of the prime elements in any geometric design.

The increasing trend towards urbanization results in larger cities; a more affluent society likewise results in increased usage and congestion on existing highway facilities. These developments cause people to spend more and more of their time in automobiles.

Figures A-1 to A-24 inclusive illustrate a number of features which are aesthetically disturbing to the motorist and, at the same time, give the designer an appreciation of the relationship between the roadway and surrounding topography. After studying these photographs it should be apparent, to all concerned, that the provision of visual comfort will help to make driving a more relaxing experience, resulting in better and safer traffic operation.

Features to be considered in producing aesthetically pleasing designs include:

- blending of the highway with the surrounding topography
- developing independent alignments for each roadway of a divided facility when right-of-way permits.
- continuous curvilinear design rather than long tangent short curve design.
- integration of horizontal and vertical alignment.
- implementation of designs producing visually pleasing structures, retaining walls and landscaping.

Many of the aforementioned principles may be achieved with little or no extra cost; in cases where additional cost is a factor, the benefits usually outweigh the extra expenditure.

It is worthy to note that an unsightly highway is a blight on the landscape; an aesthetically designed facility can become an asset to the community, enhancing the area through which it passes.

Figure A-1. To appreciate more fully the value of good design, it is instructive to observe a few examples of discontinuous alignment where "how it looks" was considered unimportant. A continuous curve beginning at the bottom of the picture and ending where the right lane disappears would have been a much superior design.

Figure A-2. These contrasting photographs illustrate vividly the difference between long tangent-short curve design vs continuous curvilinear alignment. The top view gives one the impression the designer laid out each segment of highway on a separate sheet of plan paper without regard to the continuity of the entire roadway. The other highway (bottom) flows with the natural contours of the terrain with a minimum of sudden change in alignment or grade.

Figure A-3. The AASHO Blue Book states, "Alignment should be as directional as possible, but should be consistent with the topography. A flowing line that conforms generally to the natural contours is preferable aesthetically to one with long tangents that slashes through the terrain. The construction scars can be kept to a minimum and natural slopes and plant growth can be preserved."

Figure A-4. Because of straight alignment one often can see a long distance ahead. When this happens it is almost impossible to avoid a roller-coaster appearance. Secondly, any median width changes are difficult to conceal. Observe the width change just above the grade separation structure.

Figure A-5. The Blue Book states, "The 'roller-coaster' or the 'hidden-dip' type of profile should be avoided. Such profiles generally occur on relatively straight horizontal alignment where the roadway profile closely follows a rolling natural ground line. They are unpleasant aesthetically and hazardous."

The vertical alignment, which attempts to match the rather minor "humps and hollows," is not in scale with the more liberal horizontal alignment.

Figure A-6. This example of curvilinear alignment in western Kansas enables the driver to scan the surrounding landscape without turning his head for a better view.

Figure A-7. This drawing illustrates the effect of superimposing a short vertical curve on a relatively long horizontal curve. To eliminate the appearance of a settlement of the roadway it is necessary to increase the length of vertical curve to nearly that of the horizontal curve.

Figure A-8. The sagging effect is clearly evident in this picture.

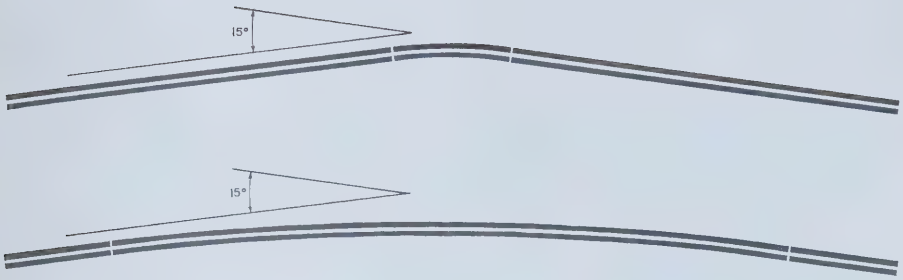

Figure A-9. For small deflection angles, curves should be sufficiently long to avoid the appearance of a kink.

Figure A-10. In this view, one has the feeling that the designer changed his mind rather suddenly and did not plan very far ahead. To avoid this, the length of curve should be proportional to the maximum distance from which one views the curve.

Figure A-11. One effect of perspective viewing is that distant objects seem nearer than they really are. Because of this the circular curve in the lower picture appears to diverge from the tangent rather rapidly and the curve no longer seems continuous. This gives the impression the designer was unable to make the curve meet the tangent properly. To remedy this situation the use of long spirals is suggested and is illustrated in the upper picture.

Figure A-12. The horizontal curve does not appear to be tangent to the straight alignment. In fact, it visually jerks away from the tangent alignment. The left-hand roadway does, however, give the driver a good "clue" that the road continues to the left and does not merely "fade away".

Figure A-13. A long spiral beginning at the first entrance at the bottom of the hill and ending near the position of the truck would have improved the appearance of this curve.

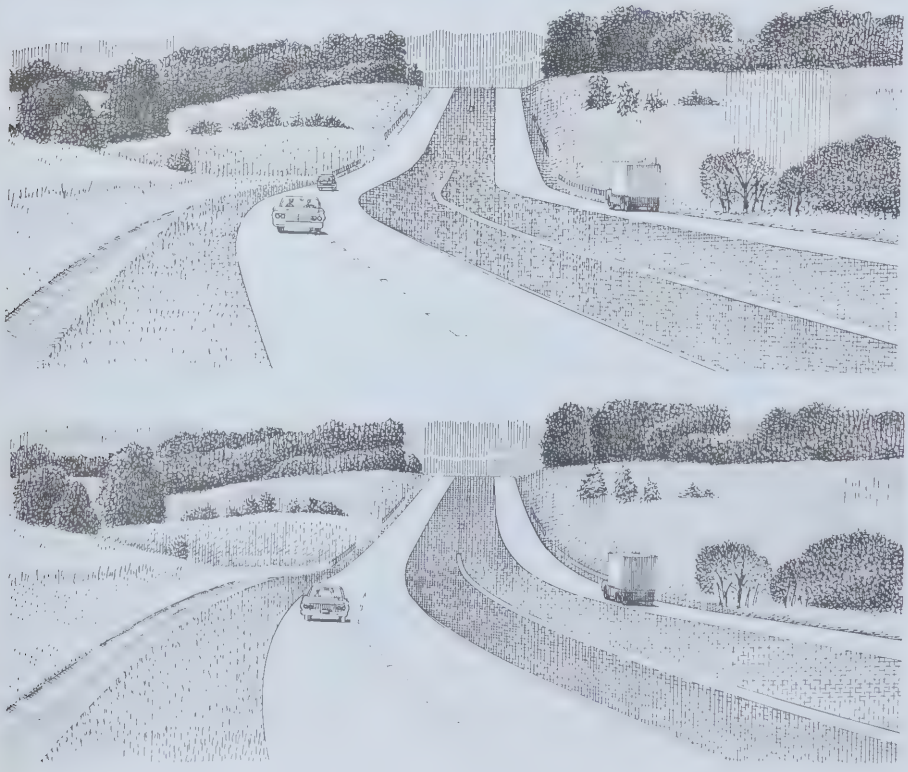

Figure A-14. Short vertical curvature at the end of a long horizontal curve will usually produce a warped appearance. This situation can be improved by using a longer vertical curve than otherwise would be needed.

Figure A-15. A short vertical curve at the beginning of a horizontal curve. Again, this is not a well-balanced design.

Figure A-16. Almost in trouble, visually.

Figure A-17. When the relatively short vertical curve in the upper picture is viewed from some distance away the transition from downgrade to upgrade appears rather abrupt. The alternatives to this design are longer vertical curves and/or curvilinear alignment to shorten the "long look" ahead.

Figure A-18. The curve at the bottom of the hill is too short when viewed from this distance.

Figure A-19. From an intermediate point the curve is only a little too short.

Figure A-20. From this position the length of vertical curve is about right.

Figure A-21. Because the vertical curve is too short, the left edge of the pavement forms a V at the bottom of the hill.

Figure A-22. The broken-back arrangement of curves (flat back, or short tangent between two curves in the same direction) should be avoided.

Figure A-23. A "broken-back" vertical alignment.

Figure A-24. More common: the broken-back with small grade changes. This type of design destroys the flowing continuity of a high speed highway. Note the jerk in horizontal alignment.

CHAPTER · B

HORIZONTAL ALIGNMENT

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Degree of Curve, Side Friction, Superelevation	B.3
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CHAPTER · B

HORIZONTAL ALIGNMENT

General Controls

In addition to the general guidelines discussed in the previous chapter relating to the aesthetics of combined vertical and horizontal alignment, there are other factors which the designer should consider when dealing with horizontal alignment.

These are listed below:

(1) The use of maximum curvature should be avoided wherever possible. In general, the central angle of each curve should be as small as the physical conditions permit so that the highway will be as directional as possible.

(2) For small deflection angles, curves should be sufficiently long to avoid the appearance of a kink. Curves should generally be of sufficient length to provide an aesthetically pleasing alignment.

(3) Sharp curves should not be introduced at the ends of long tangents. Sudden changes from areas of slight curvature to sharp curvature should be avoided. A transition area of gradually increasing curvature should be introduced to allow the driver to adjust his operating speed to the new conditions. In this way, erratic operation and accidents can be minimized as the driver will not be surprised by the need for a sudden decrease in operating speed.

(4) Long spirals should be used wherever possible, rather than compounding circular curves. It is preferable to use spirals when joining together two circular curves of different radii. However, if necessary to compound circular curves without a spiral between them, the radius of the flatter circular curve (R_1) should not be more than 33 percent greater than the radius of the sharper circular curve (R_2) i.e., R_1 should not exceed $1.33R_2$.

(5) Any abrupt reversal in alignment should also be avoided. When reverse curves are too close together, it is difficult to superelevate them adequately, thus resulting in hazardous and erratic operation. A reversal in alignment can be designed suitably by including back-to-back spirals of sufficient length, between the two curves, to allow for superelevation run-off.

(6) A broken back arrangement of curves, composed of a short tangent between two curves in the same direction, should be avoided. The use of spiral transitions or compound curves which will provide some degree of continous superelevation is preferable under such conditions. The term "broken back" is usually not applied when a connecting tangent is approximately 1,500 feet or more. Even in this case the alignment will not be of pleasing appearance when both curves are clearly visible for some distance ahead. Care should be exercised where it is necessary to change the width of medians and shoulders in order to ensure smooth, gradual tapers.

(7) Curvilinear tapers should be used rather than tangents, with the tapers proportioned evenly so as to appear uniform to the driver.

Sight Distance

Exhibit B-1 illustrates the horizontal sight distance required for passing and stopping manoeuvers. Care should be taken to ensure that adequate horizontal sight distance is always provided. One area often overlooked is the required horizontal clearance for left turning ramps on structure; here the parapet may form a sight restriction. When such a deficiency occurs the structure will require sufficient widening on the left to meet the necessary clearance, based upon the design speed of the ramp. Problems can occur with the introduction of piers and/or retaining walls on either left or right turning ramps. For instance, a 5-degree curve used in conjunction with a design speed of 60 mph requires a minimum horizontal offset of 24 feet, measured perpendicularly from the face of pier and/or retaining wall to the centre line of ramp. If the pier and/or wall is placed adjacent to the shoulder insufficient sight distance will be available.

Degree of Curve, Side Friction, Superelevation

General Factors

To obtain a balanced highway design, all geometric elements should, as far as economically feasible, be determined to provide safe, continuous operation at design speeds which are in keeping with the general conditions of the highway. In the design of highway curves, it is not only necessary to establish the proper relationship between

the design speed and curvature, but also their joint relationship with superelevation and friction. While the relationship of the factors stem from laws of mechanics, the actual values for use in design depend upon practical limits and factors determined more or less empirically over the range of variables involved. The formula $e+f = DV^2/85,900$, gives the relationship between superelevation, friction factors, degree of curve and speed used in developing tables and standards for horizontal alignment.

Different observers have recorded different maximum rates of friction, at the same speed, for similar compositions of pavements due to inherent differences in pavement roughness, weather conditions and tire condition. In general, the maximum side friction factor for dry pavement in good condition ranges from 0.5 at low speeds to 0.35 at high speeds. The value for wet pavement and smooth tires is about 0.35 at 40 mph. All studies show a decrease in friction values for an increase in speed. Because curves cannot be designed directly on the basis of these maximum coefficients of friction, safety factors must be introduced. The values choosen for design are considered safe for the vast majority of drivers. Figure B-1 (based on AASHO criteria) illustrates the friction factors used in the preparation of this manual. Two curves are shown, one for main line where the friction varies from 0.11 at 80 mph to 0.16 at 30 mph and the other for ramps which varies from 0.13 at 60 mph to 0.27 at 20 mph. Drivers are willing to accept a higher friction factor and more discomfort travelling at lower speeds on ramps than while travelling on the mainline. The desirable friction factor for any speed may be picked from these curves.

DESIGN SPEED	FRICTION FACTOR	
	*MAINLINE	†RAMP
80	·11	
70	·12	
60	·13	
50	·14	
40	·15	
35		·18
30		·20
25		·23
20		·27

*AASHO - TABLE III-5
†AASHO - FIGURE VII-7

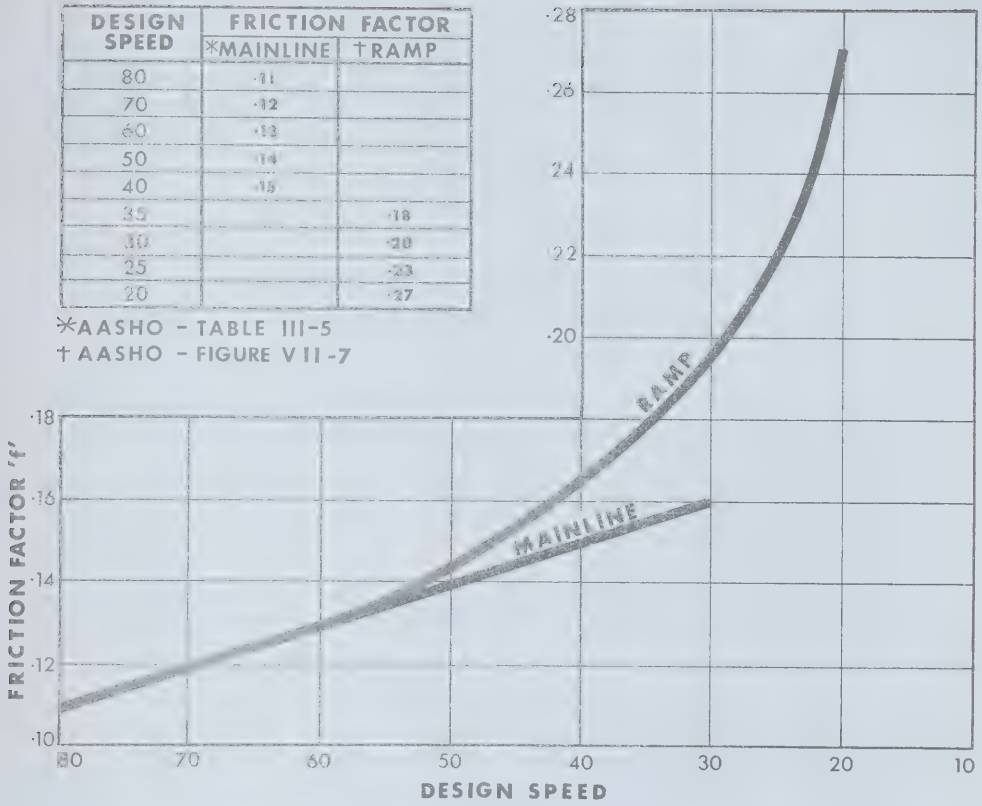


FIGURE B-1

Mainline

Rates of superelevation and lengths of spiral for mainline curvature are shown in Exhibit B-2. These are based on AASHO values for an "**e**" maximum of 0.08 feet per foot. The 0.08 rate is considered to be compatible with the winter weather conditions encountered throughout the Province. In some cases, the AASHO values for "**e**" and length of spiral have been rounded. The distribution of "**e**" and "**f**" are as per curve 4 in Figure VIII-6 (AASHO).

Ramps

Table B-1 indicates the relationship on speed when the degree of curvature and side friction factor are varied while the super-elevation rate remains constant.

TABLE B-1

EFFECT ON SPEED OF VARYING DEGREE OF CURVATURE AND SIDE FRICTION FACTOR

D	e	f	(e + f)	V (calculated)	V (rounded)
5	0.08	0.13	0.21	60	60
7	0.08	0.14	0.22	52	50
12	0.08	0.16	0.24	41.4	40
18	0.08	0.18	0.26	35	35
24	0.08	0.19	0.27	31.2	30
38	0.08	0.22	0.30	26.2	25

D= degree of Curve
e= rate of superelevation ft/ft.
f= friction, factor from Figure B-1
V= speed - mph

$$V^2 = \frac{(e + f)\ 85{,}900}{D}$$

In some instances of turning roadway and ramp geometry, the designer may be unable to achieve the desired criteria as shown in Table B-1, and must consider the effect on speed which will result from varying superelevation rate and/or side friction factors.

In order to evaluate what effect a reduction in superelevation rate has on the speed of a turning roadway Table B-2 was developed. The formula $V^2 = \frac{(e + f)\ 85{,}900}{D}$ was used in conjuntion with Figure B-1

in order to maintain the proper relationship between "**f**" and "**V**" as "**e**" was varied.

TABLE B-2*

EFFECT ON SPEED OF VARYING THE SUPERELEVATION RATE

D	e	f **	(e + f)	V
38°	.08	.22	.30	26
38°	.07	.22	.29	26
38°	.06	.23	.29	26
38°	.05	.23	.28	25
38°	.04	.23	.27	25
24°	.08	.19	.27	31
24°	.07	.20	.27	31
24°	.06	.20	.26	31
24°	.05	.20	.25	30
12°	.08	.16	.24	41
12°	.07	.16	.23	41
12°	.06	.16	.22	40
12°	.05	.17	.22	39
7°	.08	.14	.22	52
7°	.07	.14	.21	51
7°	.06	.14	.20	50
7°	.05	.15	.20	49

* - NOT for design purposes
** - from Figure B-1

Table B-3 indicates the effect on speed of using higher side friction factors. Again, the formula $V^2 = \frac{(e + f)\ 85{,}900}{D}$ was used to calculate "**f**", assuming "**V**" and holding "**e**" constant.

TABLE B-3*

EFFECT ON SPEED OF VARYING THE SIDE FRICTION FACTOR

D	e	f	(e + f)	V
38°	.08	.20	.28	25
38°	.08	.22	.30	26
38°	.08	.24	.32	27
38°	.08	.32	.40	30
38°	.08	.46	.54	35
12°	.08	.14	.22	40
12°	.08	.17	.25	42
12°	.08	.20	.28	45
12°	.08	.27	.35	50
12°	.08	.34	.42	55

* NOT for design purposes

It can readily be seen by comparing Tables B-2 and B-3 that varying the side friction factor has a greater effect on speed than varying the rate of superelevation. This explains in part why certain types of vehicles can negotiate ramps at higher speeds than others. Also, some individual drivers are willing to accept high side friction forces in order to maintain higher speeds.

It cannot be overemphasized that only design values which provide satisfactory operation for the majority of drivers must be used, otherwise, unsafe driving conditions will result.

Figure B-2 further illustrates the inter-relationship of speed, side friction factors and superelevation. For any given speed (and its corresponding side friction factor from Figure B-1), the degree of curve relating to superelevation (or vice versa) can be found.

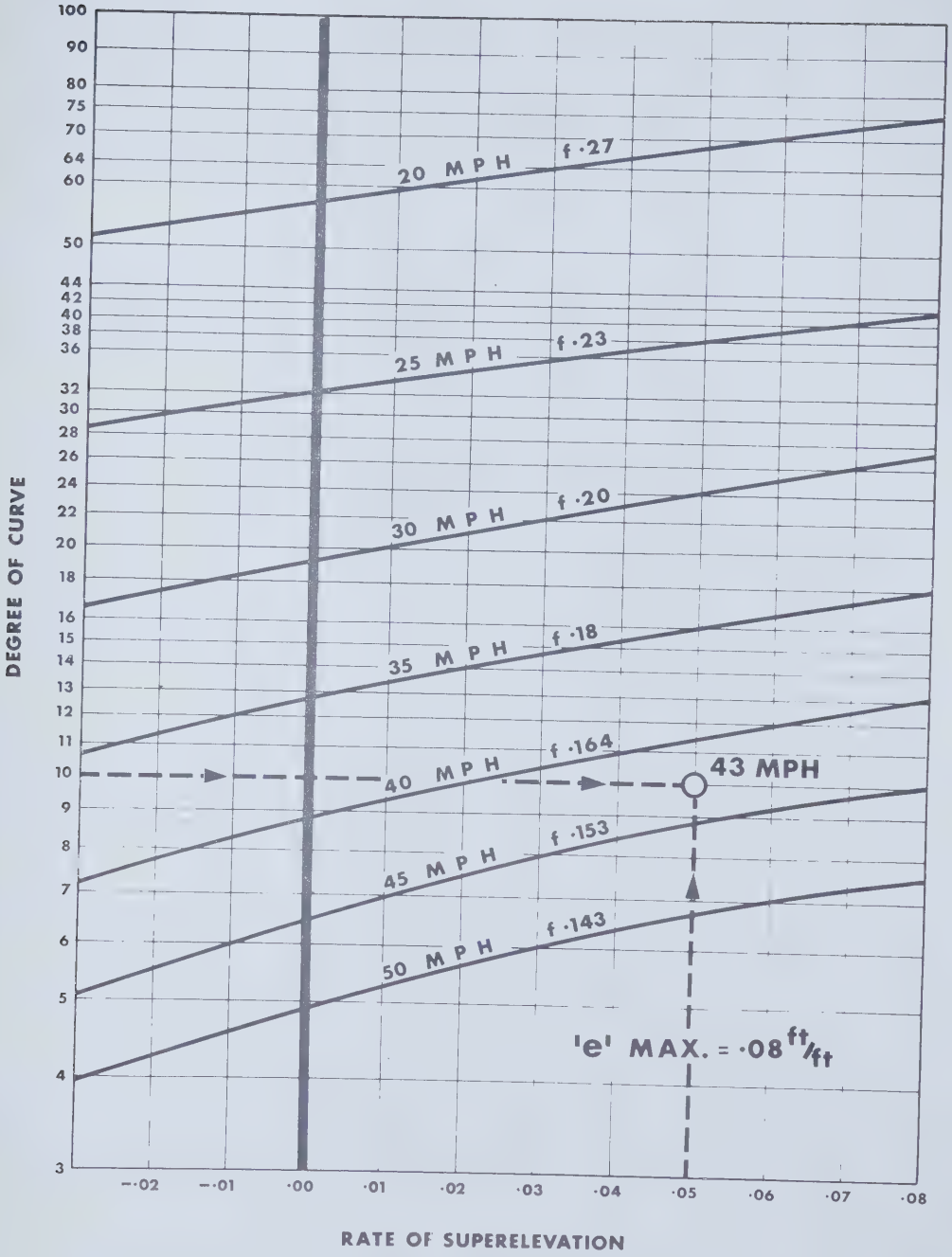

DEGREE OF CURVE
100
90
80
75
70
64
60
50
44
42
40
38
36
32
30
28
26
24
22
20
18
16
15
14
13
12
11
10
9
8
7
6
5
4
3
20 M P H f ·27
25 M P H f ·23
30 M P H f ·20
35 M P H f ·18
40 M P H f ·164
45 M P H f ·153
50 M P H f ·143
43 MPH
'e' MAX. = ·08 ft/ft
−·02
−·01
·00
·01
·02
·03
·04
·05
·06
·07
·08
RATE OF SUPERELEVATION

FIGURE B−2

The following examples illustrate the use of Figure B-2:

1. A 30 mph design speed can be maintained using a friction factor of 0.20 with the following combinations of superelevation and degree of curve:

D	e	f	V
20	.01	.20	30
22	.03	.20	30
24	.05	.20	30
26	.07	.20	30

   If a 30 mph design speed is desired on a 24-degree curve, the corresponding superelevation rate will be 0.047 (rounded to 0.05).

2. If it is only possible to achieve a superelevation rate of 0.05 on a 10-degree curve, a speed of 43 mph is obtainable. (See dotted lines figure B-2).

Figure B-2 is included for quick reference purposes and should only be used as a guide in checking design aspects such as superelevation through spiral transitions, intersection turn lanes, etc.

Two very useful guides for ramp terminal and intersection design, namely:

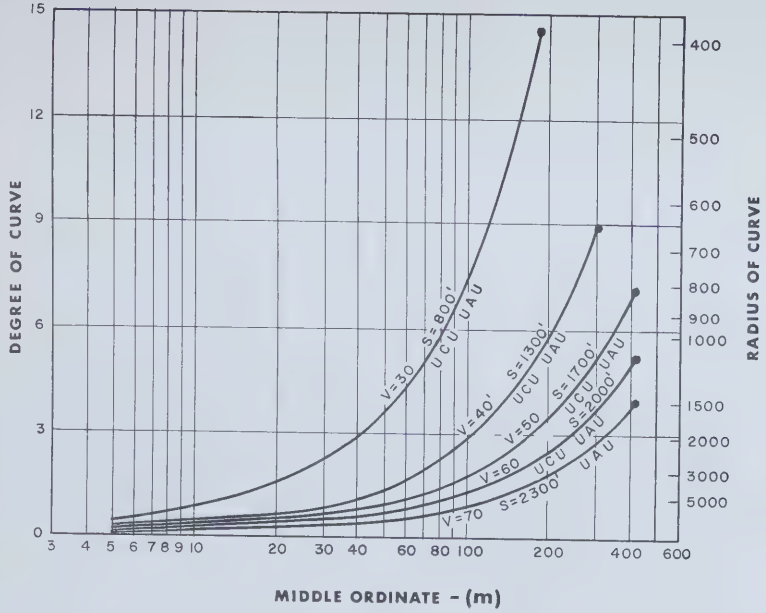
(1) Maximum rate of change of "**e**"

(2) Maximum roll-over, being the maximum allowable algebraic difference in contiguous pavement cross slopes, are provided in Table B-4 (based upon Tables VII-13 and VII-14 of AASHO).

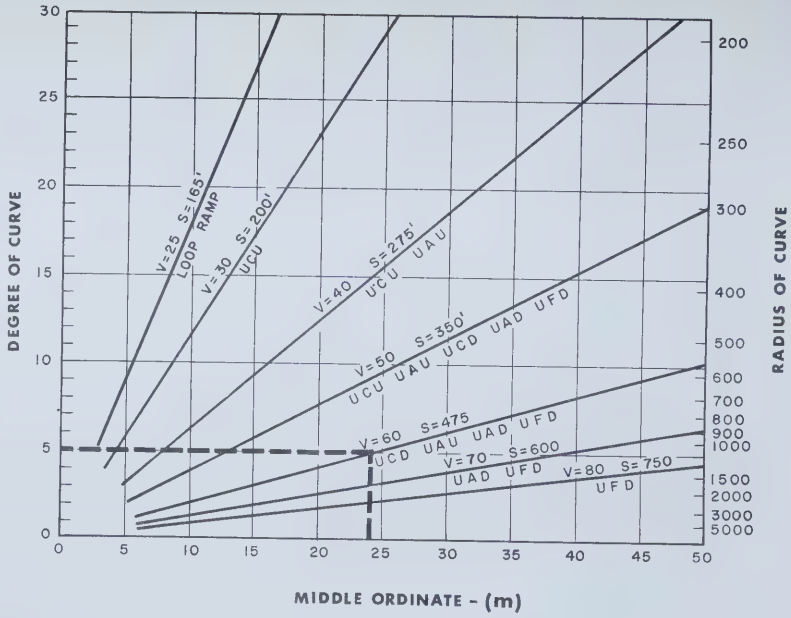
TABLE B-4

DESIGN RATE OF CROSS SLOPE CHANGE AND MAXIMUM ALGEBRAIC DIFFERENCE IN PAVEMENT CROSS SLOPE FOR INTERSECTION CURVES AND RAMP TERMINALS

Design Speed (mph)	Change in "e"		Maximum Roll Over ft/ft
	ft/ft/100	ft/ft/25	
20	0.08	0.02	0.07
25	0.07	0.017	0.06
30	0.06	0.015	0.05
35	0.05	0.012	0.05
40	0.05	0.012	0.05
45	0.05	0.012	0.05
50	0.05	0.012	0.05



PASSING SIGHT


DEGREE OF CURVE
RADIUS OF CURVE
MIDDLE ORDINATE - (m)
V=25 S=165' LOOP RAMP UCU
V=30 S=200' UCU UAU
V=40 S=275' UCU UAU
V=50 S=350' UCU UAU UCD UAD UFD
V=60 S=475 UCD UAU UAD UFD
V=70 S=600 UAD UFD
V=80 S=750 UFD

STOPPING SIGHT

PROVINCE OF ALBERTA
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HORIZONTAL SIGHT DISTANCE

V = DESIGN SPEED M.P.H.
S = STOPPING SIGHT DISTANCE
R = RADIUS OF CURVE
D = DEGREE OF CURVE
m = MIDDLE ORDINATE

NOTE

ALL DISTANCES MEASURED ALONG OR FROM ℄ OF LANE ADJACENT TO OBSTRUCTION.

EXAMPLE

GIVEN: 5°-60 MPH DESIGN SPEED.
FIND: MIN. OFFSET TO HOR. OBSTRUCTION TO PROVIDE REQUIRED STOPPING DISTANCE.
ANSWER: 24'

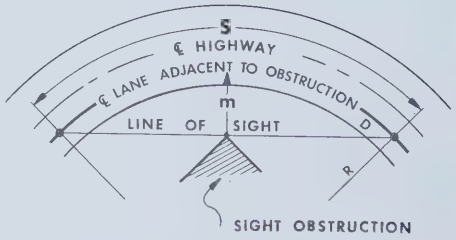

EXHIBIT B-1

SUPERELEVATION AND MINIMUM SPIRAL LENGTH

CLASS		U.A.U. 30 U.A.D. 30			U A.U. 40 U.A.D. 40			U.A.D. 50 U.F.D. 50					U. A. D. 60 U. F. D. 60					U.F.D. 65					U.F.D. 70					U.F.D. 75 R.F.D. 75					U.F.D. 80, R.F.D. 80				
D	R	e	L feet		e	L feet		e	L feet				e	L feet				e	L feet				e	L feet				e	L feet				e	L feet			
			2-lane	4-lane		2-lane	4-lane		2-lane	4-lane	6-lane	8-lane		2-lane	4-lane	6-lane	8-lane		2-lane	4-lane	6-lane	8-lane		2-lane	4-lane	6-lane	8-lane		2-lane	4-lane	6-lane	8-lane		2-lane	4-lane	6-lane	8-lane
0°-15'	22918'	N.C	0	0	N.C	0	0	N.C	0	0	0	0	N.C	0	0	0	0	N.C	0	0	0	0	N.C	0	0	0	0	N.C	0	0	0	0	R.C	240	240	250	250
0°-30'	11459'	N.C	0	0	N.C	0	0	N.C	0	0	150	150	R.C	175	175	200	200	R.C	190	190	200	200	R.C	200	200	200	200	.022	220	220	250	250	.024	240	240	250	250
0°-45'	7639'	N.C	0	0	N.C	0	0	R.C	150	150	150	150	.022	175	175	200	200	.025	190	190	200	200	.029	200	200	200	220	.032	220	220	250	250	.036	240	240	250	300
1°-00'	5730'	N.C	0	0	R.C	125	125	.021	150	150	150	150	.029	175	175	200	200	.033	190	190	200	240	.038	200	200	230	290	.043	220	220	270	340	.047	240	240	310	390
1°-30'	3820'	R.C	100	100	.021	125	125	.030	150	150	150	160	.040	175	175	220	270	.046	190	200	260	330	.053	200	240	320	400	.060	220	290	380	400	.065	240	320	430	540
2°-00'	2865'	R.C	100	100	.027	125	125	.038	150	150	180	230	.051	175	210	280	340	.057	190	250	330	410	.065	200	290	390	490	.072	230	340	450	570	.076	250	380	500	630
2°-30'	2292'	.021	100	100	.033	125	125	.046	150	170	220	260	.060	175	240	320	410	.066	190	290	380	470	.073	220	330	440	550	.078	250	370	490	620	.080	260	400	530	660
3°-00'	1910'	.025	100	100	.038	125	125	.053	150	190	250	320	.067	180	270	360	450	.073	210	320	420	520	.078	230	350	470	590	.080	250	380	510	630	.080	260	400		
3°-30'	1637'	.028	100	100	.043	125	140	.058	150	210	280	350	.073	200	300	390	490	.077	220	330	440	550	.080	240	360	480	600	.080	250	380			D-MAX. 2·5°				
4°-00'	1432'	.032	100	100	.047	125	150	.063	150	230	300	380	.077	210	310	420	520	.079	230	340	450	560	.080	240	360			D-MAX. 3·0°									
5°-00'	1146'	.038	100	100	.055	125	170	.071	170	260	340	430	.080	220	320	430	540	.080	230	350			D-MAX. 3·5°														
6°-00'	955'	.043	100	120	.061	130	190	.077	180	280	370	460	.080	220	320			D-MAX. 4·5°																			
7°-00'	819'	.048	100	130	.067	140	210	.079	190	280	380	470	D-MAX. 5·0°																								
8°-00'	716'	.052	100	140	.071	150	220	.080	190	290																											
9°-00'	637'	.056	100	150	.075	160	240	D-MAX. 7·5°																													
10°-00'	573'	.059	110	160	.077	160	240																														
11°-00'	521'	.063	110	170	.079	170	250																														
12°-00'	477'	.066	120	180	.080	170	250																														
13°-00'	441'	.068	120	180	.080	170	250																														
14°-00'	409'	.070	130	190	D-MAX. 12·5°																																
16°-00'	358'	.074	130	200																																	
18°-00'	318'	.077	140	210																																	
20°-00'	286'	.079	140	210																																	
22°-00'	260'	.080	140	220																																	
		.080	140	220																																	
		D-MAX. 23·0°																																			

SPIRAL LENGTHS SHOWN ARE MINIMUM.
USE HIGHER VALUES WHERE POSSIBLE.
SPIRALS DESIRABLE BUT NOT ESSENTIAL
ABOVE HEAVY LINE.

'e' MAX. = 0·08 Ft./Ft.

LEGEND

D = DEGREE OF CURVE.
R = RADIUS OF CURVE.
'e' = RATE OF SUPERELEVATION.
L = MIN. LENGTH OF RUNOFF OR SPIRAL CURVE.
NC = NORMAL CROWN SECTION.
RC = REMOVE ADVERSE CROWN. SUPERELEVATE AT NORMAL CROWN SLOPE.

NOTE:

1. ALL VALUES SHOWN ARE BASED ON AASHO'S POLICY OF GEOMETRIC DESIGN FOR RURAL HIGHWAYS, 1965.

2. 2, 4, 6 & 8 REFER TO THE TOTAL NUMBER OF LANES IN BOTH DIRECTIONS.
   EX. – 6 = 6 LANE FREEWAY = 3 LANES IN EACH DIRECTION.

3. SPIRAL LENGTHS FOR 3 LANE AND 5 LANE ROADWAYS CAN BE FOUND AS FOLLOWS.
   3 LANES = 1·2 X 2 LANE VALUES
   5 LANES = 1·75 X 2 LANE VALUES
   EX. – 3 LANES – 60 M.P.H. – 5° CURVE
   Ls = 1·2 X 220 = 264 = 270 FEET.

4. VALUES SHOWN IN TABLE ARE FOR UNDIVIDED AND DIVIDED ROADWAYS WITH MEDIANS UP TO 20 FEET IN WIDTH.
   EX. – 6 LANE ROADWAY
   18 FOOT WIDE MEDIAN
   60 M.P.H., 2° CURVE
   e = 0·051, Ls = 280 FEET.

5. FOR RAISED MEDIAN WIDTHS FROM 20 FT. TO 40 FT, THE Ls VALUES MAY BE REDUCED BY CONSIDERING THE TWO DIRECTIONS AS SEPARATED ROADWAYS. Ls IS THEN FOUND IN SAME MANNER AS SHOWN IN NOTE 3.
   EX. – 6 LANE ROADWAY – 28 FOOT RAISED MEDIAN WITH GUARD RAIL, 70 M.P.H., 3°30' CURVE.
   Ls = 480 FEET DESIRABLE FROM TABLE FOR 6 LANES.
   Ls FOR 3 LANES = 1·2 X 240 = 288 = 290 ABSOLUTE MINIMUM.
   EXCEPT IN EXTREME CASES, VALUES HIGHER THAN THE 290 SHOULD ALWAYS BE USED.

6. WHERE THE MEDIAN WIDTH IS OVER 40 FEET THE TWO ROADWAYS CAN BE CONSIDERED AS SEPARATED ROADWAYS.
   EX. – 4 LANE FREEWAY
   70 M.P.H., 2° CURVE
   50 FOOT MEDIAN
   USE 2 LANES
   e = 0·065, Ls = 200 FEET
   EX. – 6 LANE FREEWAY
   70 M.P.H., 2° CURVE
   40 FOOT MEDIAN
   USE 3 LANES
   e = 0·065, Ls = 1·2 X 200 = 240 FT.

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SUPERELEVATION
MAINLINE

CHAPTER · C

VERTICAL ALIGNMENT

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Development of Superelevation	C.3
Tangent to Curve	
Reverse Curves	

EXHIBITS	No.
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Superelevation - Tangent to Curve	
Method of Revolving Pavement	C-2
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Method of Revolving Pavement	C-4
Profile Design	C-5

CHAPTER · C

VERTICAL ALIGNMENT

General Controls

The discussion of aesthetic considerations in Chapter A emphasizes the need for proper co-ordination of vertical and horizontal alignments in order to produce a safe, satisfactory over-all design. If the desired co-ordinated design is to be achieved, attention must be given to the following general controls for vertical alignment:

(1) A smooth grade line with gradual changes, consistent with the type or class of highway and the character of the terrain, is preferable to an alignment with numerous breaks and short lengths of grade.

(2) The "roller-coaster" or "hidden dip" type of profile should be avoided.

(3) A broken-back grade line (two vertical curves in the same direction separated by a short section of tangent grade) is not desirable, particularly in sags where a full view of the profile is possible.

(4) Where intersections at-grade occur on a highway with moderate to steep grades, it is desirable to reduce the gradient through the intersection. Such a profile change is beneficial for vehicles making turns and stopping and serves to reduce potential hazards.

(5) In sections where curb and gutter are used, the desirable minimum longitudinal grade on gutters should be 0.5 percent. Within superelevated transition areas it may sometimes be virtually impossible to provide this minimum grade; in such cases, the longitudinal grade length below 0.5 percent should be kept as short as possible.

(6) Special attention is required when superelevation transitions occur on a vertical curve in order to ensure that the required "**K**" value is achieved across the entire width of pavement. For example, the profile of the lane on the opposite side of the roadway from the control line may have a reduced "**K**" value due to the effect of the change in "**e**" rate required by the superelevation transition. It is, therefore, necessary to check both edge profiles and adjust where necessary in order to maintain the desired minimum "**K**" value.

(7) All calculated pavement edges should be carefully checked with a spline to assure that a smooth profile is attained.

Stopping-Sight Distance

Minimum and desirable stopping sight distance values for crest and sag vertical curves including "length of vertical curve" charts are shown on Exhibit C-1.

The minimum stopping sight distances indicated, in accordance with AASHO, are based on wet pavement and the average running speed of the highway. The desirable values are based on wet pavement and the highway design speed.

The "length of vertical curve" charts, as per AASHO, are based on average running speed.

The "**K**" values listed are computed on the basis of both design and average running speed. While it is recognized that higher "**K**" values may not always be attainable, in order to ensure that a smooth, safe profile be achieved, it is recommended that every effort be made to utilize the longest vertical curves possible.

Development of Superelevation

Tangent to Curve

Exhibits C-2 and C-3 illustrate a method of superelevation development for multi-lane highways. Exhibit C-2 shows the cross-sections as they rotate from the tangent to the superelevated section. Sections (A), (C) and (K) are located on tangent, at the T.S. and S.C. points respectively. Assuming a 70 mph design speed, the allowable rate of change of "**e**" is 0.01 foot per foot in 30 feet for two lanes and 0.01 foot per foot in 36 feet for three lanes. Sections (A), (B), (C), (D), and (E) are 30 feet apart as only two lanes are rotating. However, from Section (E) to (G), three lanes are rotating and 40 feet is used. From (G) to (K), three lanes plus the inside shoulder are rotating and more than 40 feet is required. The spiral length for six lanes and 70 mph , with a 28 foot median, is 290 feet minimum (Exhibit B-2, Note 5). Therefore, 300 feet has been used which provides 40 feet in the area between Sections (G) and (K).

The superelevation transition is calculated and plotted as shown by the table and graph on Exhibit C-3. The calculated points are plotted above and below the dashed control profile line. After plotting these lines, a spline is used to develop a smooth profile through the points. While it is not possible to pass through each

point, the points are used to check the final line and superelevation values to ensure that the rate of change of "**e**" is acceptable in all locations. The tangent runout actually requires 100 feet instead of the theoretical 60.

Exhibit C-3 indicates the need for a spiral longer than 300 feet. If in this case a 400 or 500 foot spiral had been employed, the points could have been spread out in excess of 40 feet, to accommodate the full shoulder width, and a smooth profile developed to allow full superelevation at the S.C. rather than beyond this point.

Reverse Curves

Exhibits C-4 and C-5 are similar to Exhibits C-2 and C-3 except a back to back spiral transition is used to effect a reversal of curvature. In order to effect a minimum transition, 640 feet rather than double the 290 feet of Exhibit C-3 is required. This extra length is necessary because all three lanes are rotating at all times requiring 40 feet between each section. Again, a longer transition is desirable as no allowance was made for the extra width of the inside shoulder.

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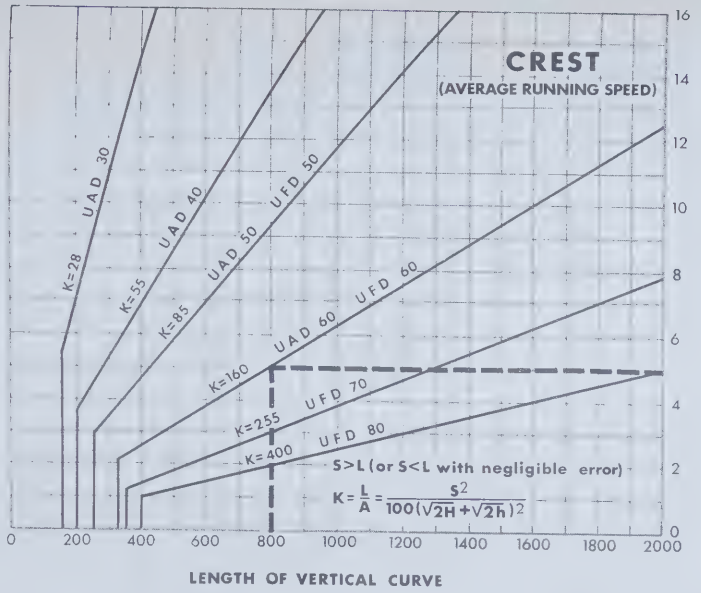
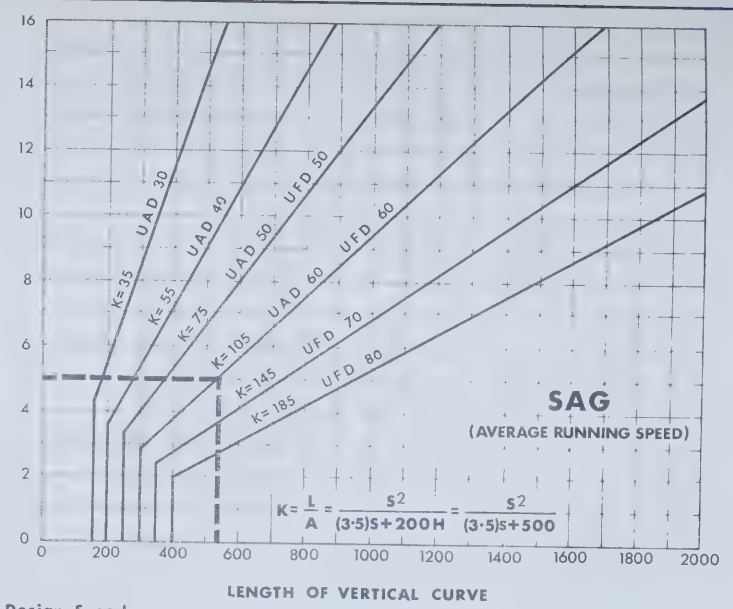
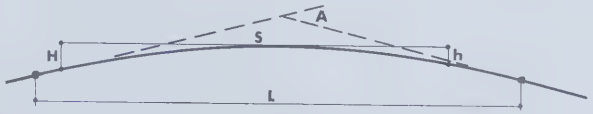
STOPPING SIGHT DISTANCE
VERTICAL CURVES


CREST
(AVERAGE RUNNING SPEED)
K=28 UAD 30
K=55 UAD 40
K=85 UAD 50 UFD 50
K=160 UAD 60 UFD 60
K=255 UFD 70
K=400 UFD 80
S>L (or S<L with negligible error)
$K = \frac{L}{A} = \frac{S^2}{100(\sqrt{2H}+\sqrt{2h})^2}$
0 200 400 600 800 1000 1200 1400 1600 1800 2000
0 2 4 6 8 10 12 14 16
LENGTH OF VERTICAL CURVE

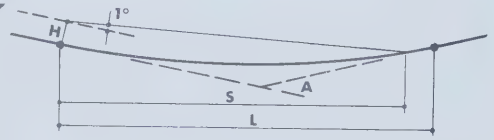
ALGEBRAIC DIFFERENCE IN GRADES


SAG
(AVERAGE RUNNING SPEED)
K=35 UAD 30
K=55 UAD 40
K=75 UAD 50 UFD 50
K=105 UAD 60 UFD 60
K=145 UFD 70
K=185 UFD 80
$K = \frac{L}{A} = \frac{S^2}{(3{\cdot}5)S+200H} = \frac{S^2}{(3{\cdot}5)S+500}$
0 200 400 600 800 1000 1200 1400 1600 1800 2000
0 2 4 6 8 10 12 14 16
LENGTH OF VERTICAL CURVE

(Absolute minimum L = 5 × Design Speed



L = Length of vertical curve in feet.
A = Algebraic difference in grades %
S = Minimum stopping sight distance in feet.
H = Height of drivers eyes = 3·75 ft.
h = Height of obstruction = 0·50 ft.



L = Length of vertical curve in feet.
A = Algebraic difference in grades %
S = Minimum stopping sight distance in feet.
H = Height of head lamps = 2·5 ft.
1° = Angle of light beam upward from plane of vehicle

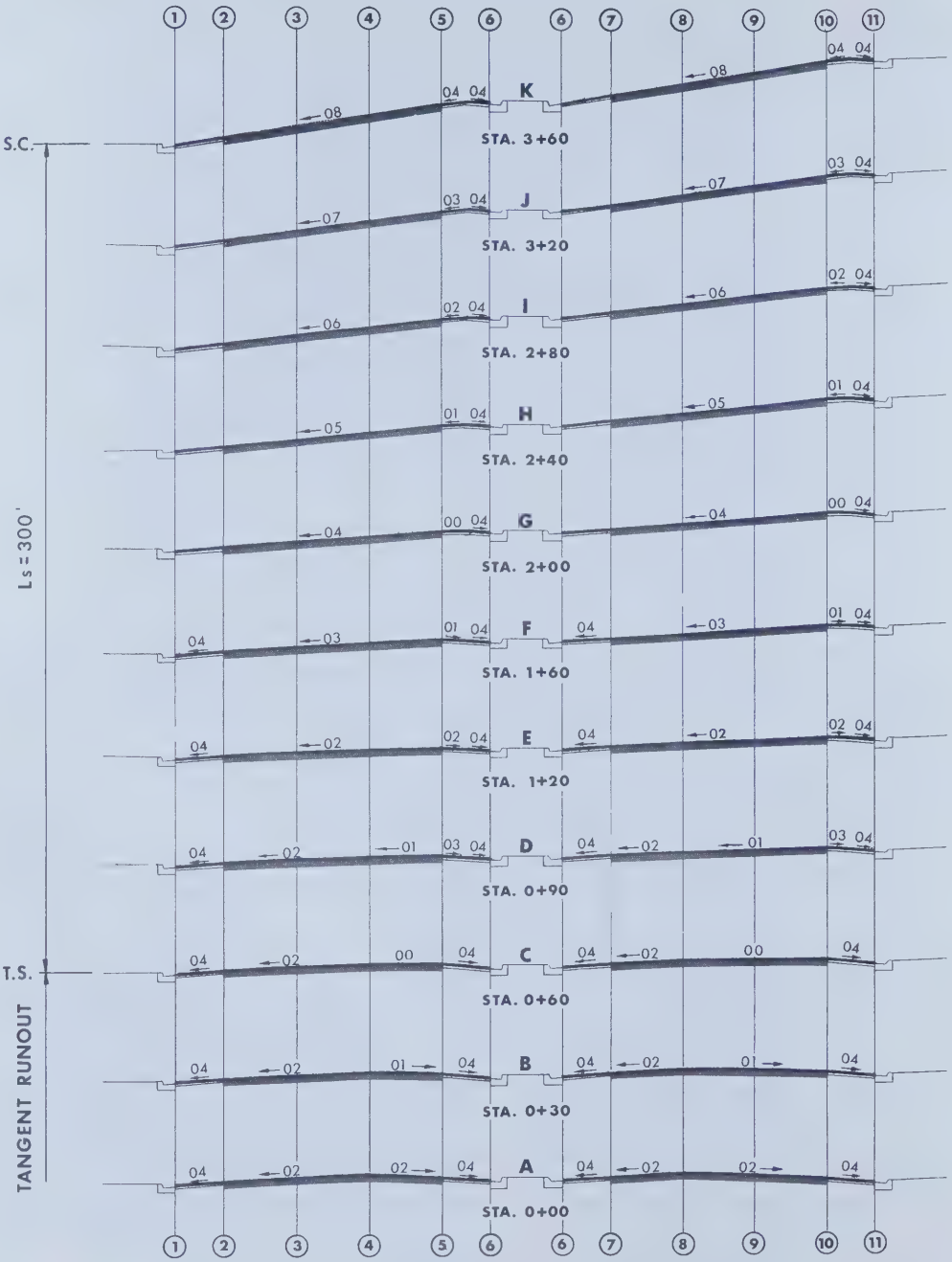
DESIGN SPEED / AVE RUNNING SPEED	STOPPING SIGHT DISTANCE	CREST		SAG	
		* MIN. K	† DES. K	* MIN. K	† DES. K
30 / 28	200 × † 200	28	28	35	35
40 / 36	275 × 325	55	70	55	70
50 / 44	350 × 450	85	150	75	100
60 / 52	475 × 625	160	300	105	150
70 / 58	600 × 850	255	500	145	200
80 / 64	750 × 1050	400	800	185	280

* Minimum rounded values from AASHO Blue Book, 1965 (based on average running speed)

† Desirable rounded values (based on design speed)

EXHIBIT C-1

EXHIBIT C-2



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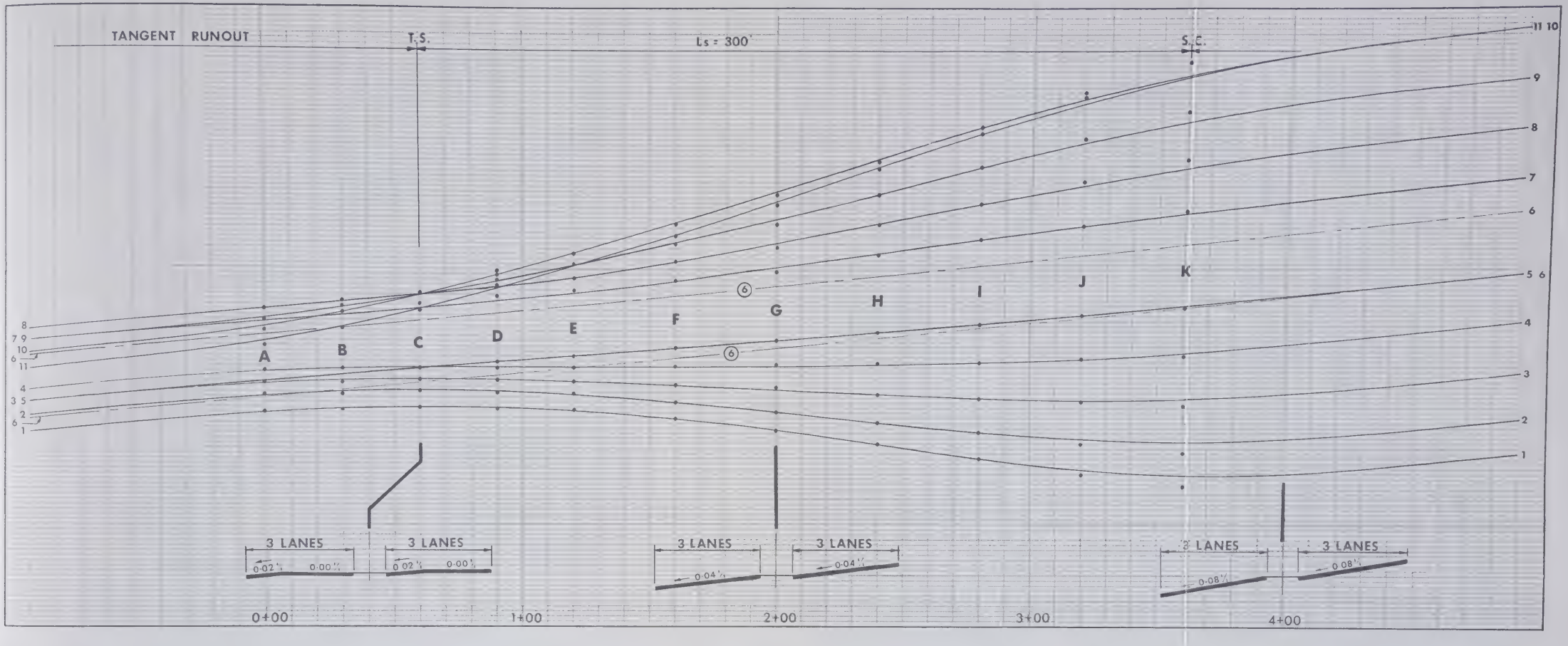
NOTE: POINT ⑥ IS PROFILE CONTROL.

METHOD OF REVOLVING PAVEMENT

(AS SHOWN IN EXHIBIT C-3)



SECTION	LEFT SIDE 1	2	3	4	5	6	RIGHT SIDE 6	7	8	9	10	11	SECTION
A	−0·24	+0·08	+0·32	+0·56	+0·32	0·00	0·00	+0·32	+0·56	+0·32	+0·08	−0·24	A
B	−0·36	−0·04	+0·20	+0·44	+0·32	0·00	0·00	+0·32	+0·56	+0·44	+0·32	0·00	B
C	−0·48	−0·16	+0·08	+0·32	+0·32	0·00	0·00	+0·32	+0·56	+0·56	+0·56	+0·24	C
D	−0·64	−0·32	−0·08	+0·16	+0·28	0·00	0·00	+0·32	+0·56	+0·68	+0·80	+0·52	D
E	−0·80	−0·48	−0·24	0·00	+0·24	0·00	0·00	+0·32	+0·56	+0·80	+1·04	+0·80	E
F	−1·20	−0·88	−0·52	−0·16	+0·20	0·00	0·00	+0·32	+0·68	+1·04	+1·40	+1·20	F
G	−1·60	−1 28	−0·80	−0·32	+0·16	0·00	0·00	+0·32	+0·80	+1·28	+1·76	+1·60	G
H	−2·08	−1·68	−1·08	−0·48	+0·12	0·00	0·00	+0·40	+1·00	+1·60	+2·20	+2·08	H
I	−2·56	−2·08	−1·36	−0·64	+0·08	0·00	0·00	+0·48	+1·20	+1·92	+2·64	+2·56	I
J	−3·04	−2·48	−1·64	−0·80	+0·04	0·00	0·00	+0·56	+1·40	+2·24	+3·08	+3·04	J
K	−3·52	−2 88	−1·92	−0·96	0·00	0·00	0·00	+0·64	+1·60	+2·56	+3·52	+3·52	K

NOTES:
1. THESE ARE TWO SEPARATE PROFILES, ONE FOR THE LEFT ROADWAY AND ONE FOR THE RIGHT ROADWAY, SHOWN TOGETHER FOR COMPARISON AND WITHOUT REFERENCE TO RELATIVE ELEVATIONS.
2. PROFILE 6 IS THE CONTROL LINE AND IS COMMON FOR BOTH ROADWAYS.
3. IN THIS EXAMPLE BOTH LEFT AND RIGHT SHOULDER WIDTHS OF 8 FT. HAVE BEEN ASSUMED FOR CONVENIENCE. IN ACTUAL DESIGN, SHOULDER WIDTHS UTILIZED ARE TO BE IN ACCORDANCE WITH CHAPTER 'E'.

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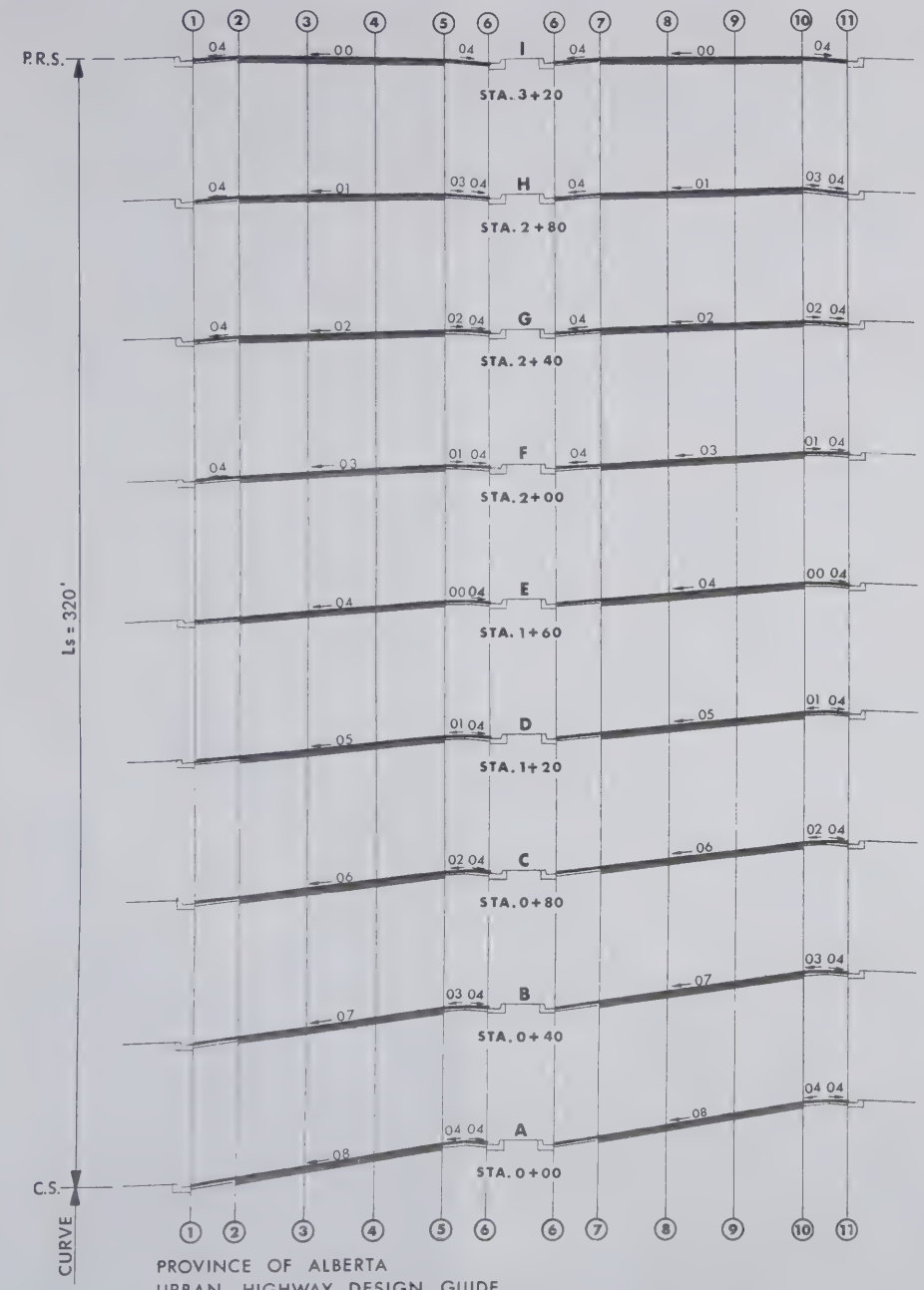
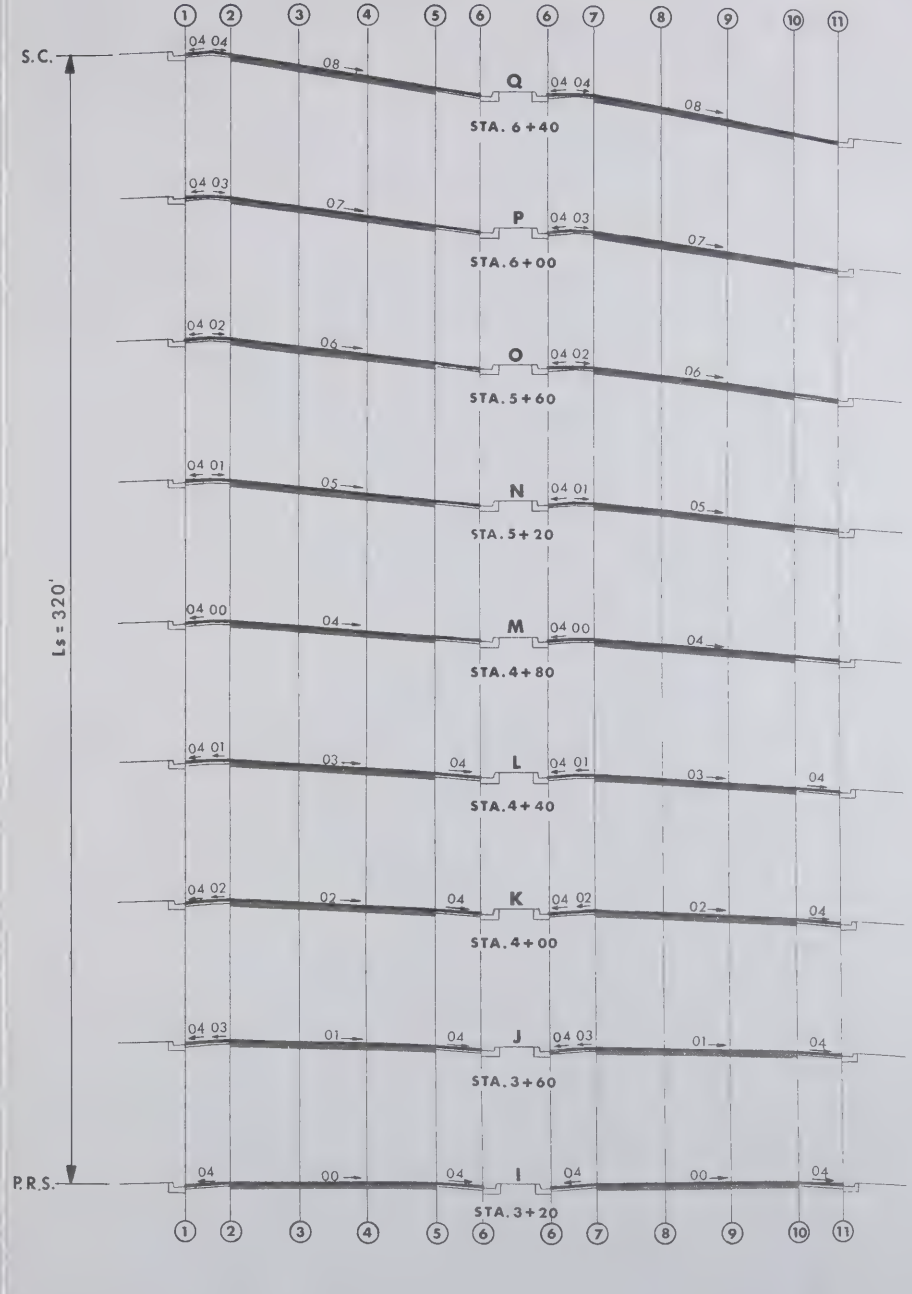
DEVELOPMENT OF SUPERELEVATION TANGENT TO CURVE

EXHIBIT C-4





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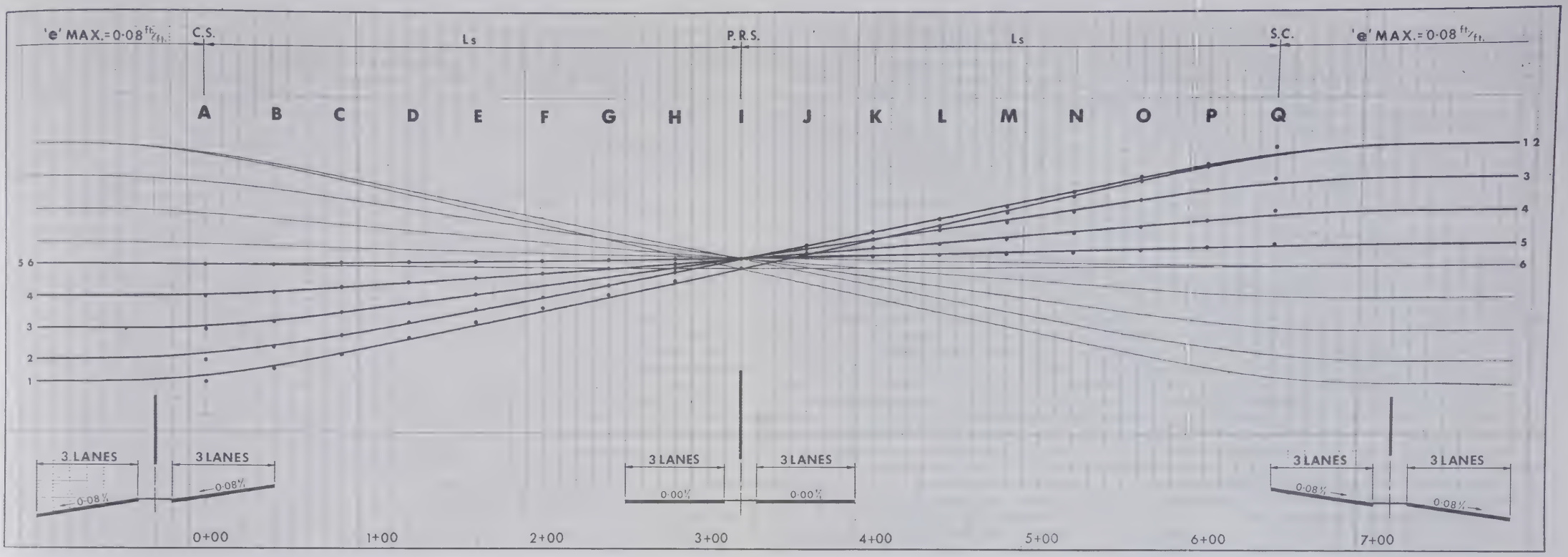
METHOD OF REVOLVING PAVEMENT

(AS SHOWN IN EXHIBIT C-5)

NOTE: POINT ⑥ IS PROFILE CONTROL.



SECTION	LEFT SIDE						RIGHT SIDE						SECTION
	1	2	3	4	5	6	6	7	8	9	10	11	
A	−3·52	−2·88	−1·92	−0·96	+0·00	0·00	0·00	+0·64	+1·60	+2·56	+3·52	+3·52	A
B	−3·04	−2·48	−1·64	−0·80	+0·04	0·00	0·00	+0·56	+1·40	+2·24	+3·08	+3·04	B
C	−2·56	−2·08	−1·36	−0·64	+0·08	0·00	0·00	+0·48	+1·20	+1·92	+2·64	+2·56	C
D	−2·08	−1·68	−1·08	−0·48	+0·12	0·00	0·00	+0·40	+1·00	+1·60	+2·20	+2·08	D
E	−1·60	−1·28	−0·80	−0·32	+0·16	0·00	0·00	+0·32	+0·80	+1·28	+1·76	+1·60	E
F	−1·20	−0·88	−0·52	−0·16	+0·20	0·00	0·00	+0·32	+0·68	+1·04	+1·40	+1·20	F
G	−0·80	−0·48	−0·24	−0·00	+0·24	0·00	0·00	+0·32	+0·56	+0·80	+1·04	+0·80	G
H	−0·40	−0·08	+0·04	+0·16	+0·28	0·00	0·00	+0·32	+0·44	+0·56	+0·68	+0·40	H
I	−0·00	+0·32	+0·32	+0·32	+0·32	0·00	0·00	+0·32	+0·32	+0·32	+0·32	0·00	I
J	+0·40	+0·68	+0·56	+0·44	+0·32	0·00	0·00	+0·28	+0·16	+0·04	−0·08	−0·40	J
K	+0·80	+1·04	+0·80	+0·56	+0·32	0·00	0·00	+0·24	+0·00	−0·24	−0·48	−0·80	K
L	+1·20	+1·40	+1·04	+0·68	+0·32	0·00	0·00	+0·20	−0·16	−0·52	−0·88	−1·20	L
M	+1·60	+1·76	+1·28	+0·80	+0·32	0·00	0·00	+0·16	−0·32	−0·80	−1·28	−1·60	M
N	+2·08	+2·20	+1·60	+1·00	+0·40	0·00	0·00	+0·12	−0·48	−1·08	−1·68	−2·08	N
O	+2·56	+2·64	+1·92	+1·20	+0·48	0·00	0·00	+0·08	−0·64	−1·36	−2·08	−2·56	O
P	+3·04	+3·08	+2·24	+1·40	+0·56	0·00	0·00	+0·04	−0·08	−1·64	−2·48	−3·04	P
Q	+3·52	+3·52	+2·56	+1·60	+0·64	0·00	0·00	+0·00	−0·96	−1·92	−2·88	−3·52	Q

NOTES:

1. THESE ARE TWO SEPARATE PROFILES, ONE FOR THE LEFT ROADWAY AND ONE FOR THE RIGHT ROADWAY, SHOWN TOGETHER FOR COMPARISON AND WITHOUT REFERENCE TO RELATIVE ELEVATIONS.
2. PROFILE 6 IS THE CONTROL LINE AND IS COMMON FOR BOTH ROADWAYS.
3. IN THIS EXAMPLE BOTH LEFT AND RIGHT SHOULDER WIDTHS OF 8 FT. HAVE BEEN ASSUMED FOR CONVENIENCE. IN ACTUAL DESIGN, SHOULDER WIDTHS UTILIZED ARE TO BE IN ACCORDANCE WITH CHAPTER 'E'.

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DEVELOPMENT OF SUPERELEVATION REVERSE CURVES

CHAPTER · D

ARTERIAL STREETS

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CHAPTER · D

ARTERIAL STREETS

The arterial streets referred to herein are categorized according to the CGRA classifications of "Urban Arterial Undivided" (UAU) and "Urban Arterial Divided" (UAD). Portions of the chapters dealing with horizontal and vertical alignment, typical sections, guardrail, exit and entrance terminals are applicable to these categories.

Aspects of arterial street design pertaining to left turn lanes, right turn lanes and medians are considered in this chapter.

Left Turn Lanes

Intersection capacity is increased substantially, and standing left turn vehicles are given a measure of protection, by the incorporation of an added traffic lane within a median in the vicinity of intersections. Such added left turn lanes are possible on UAD streets where a median of sufficient width has been provided, and on UAU streets where a short section of median has been introduced at particular intersections in order to increase capacity.

Recommended design criteria for left turn lanes, or bays, is shown on Exhibit D-1. Total bay lengths are indicated as **Ls** for signalized intersections and **Lu** for unsignalized intersections. The total bay length combines a taper distance (**T**) with a storage length (S_1) for signalized intersections and a length ($S_1 + S_2$) for unsignalized intersections. In the latter case, S_1 represents

a portion of the deceleration distance while S_2 is the required storage length.

Taper - **T**

The taper distances shown are the rounded values from AASHO, Table VII-9, for speed change lane tapers. The taper consists of two curves, both with degree of curve (**D**) separated by a length of tangent which approximates 1/3 **T**.

It should be noted that these taper designs are equally appropriate for locations where:

(a) speed change lanes are required and right-of-way restrictions dictate that they be parallel to the through lanes,

(b) a separate right turn lane is required to increase intersection capacity, and right-of-way restrictions or vehicular volumes dictate that it be parallel to the through lanes.

Storage Lengths (S_1 and S_2)

The distance (S_1) required to store vehicles waiting to turn left at a signalized intersection is calculated on normal capacity requirements for each particular intersection and its design hour volumes. The storage length required at unsignalized intersections (S_2) is also related to design hour volumes, only in this case is based on a prediction of the frequency of gaps in the opposing traffic stream which will permit left turns to be made safely.

Bay Length (**Ls**) - Signalized Intersections

Minimum left turn bay lengths are predicated on the total distance

required to decelerate from the design speed of the arterial street, at the beginning of the taper, to a stop condition at the intersection. The values of **Ls** shown in Exhibit D-1 for design speeds of 40 and 50 mph are taken from AASHO (Table VII-10: deceleration lanes) and the value for 30 mph determined by extrapolating the AASHO values.

Only when there are no waiting vehicles in the bay will it be possible to complete deceleration in the **Ls** distance. As the number of stored vehicles increases it will be necessary for additional left turning vehicles to begin deceleration on the through lanes in advance of the taper. This is considered acceptable practice at signalized intersections because of the stop-and-go nature of through traffic operations. If the intersection analysis indicates a storage requirement, for standing vehicles, in excess of the minimum distance required to decelerate to a stop, S_1 can be increased accordingly.

Bay Length (**Lu**) - Unsignalized Intersections

Because of the different operational nature of through traffic at unsignalized intersections it is recommended that all deceleration take place within the length of the left turn bay. The total bay length in this case then becomes the minimum distance required to decelerate to a stop (**Ls**-min.) plus the required storage length (S_2).

A design which utilizes the same criteria to determine **Lu** is also preferable at signalized intersections, if space permits, since it provides (a) an added safety factor and (b) increases the capacity reserve, which may be required in the event of a traffic volume increase being greater than that predicated.

Right Turn Lanes

Several examples of tapered right turn designs are portrayed on Exhibit D-3. Their purpose is basically to provide a means whereby vehicles can complete a right turn maneuver without being stopped by traffic waiting for the green signal phase. Each is based on the premise that the intersection is signalized and that right turning traffic will yield, rather than merge immediately, with through traffic.

Taper

In keeping with the AASHO recommendation that added tapered lanes at intersection and ramp approaches are superior to additional parallel lanes, a 4 degree taper has been used in each of the examples. The 4 degree curve is considered a reasonable compromise between flatter curves, which produce narrow inefficient pavement slivers, and sharper curves, which do not provide the required taper length.

In each case the taper is started at a point which will effect a 12 foot pavement widening 100 feet in advance of the cross-street stop line. With this type of design a queue of 5 passenger vehicles can be stored in the outside through lane and still permit right turning vehicles to proceed. Should an intersection analysis indicate the need for a greater storage requirement, either the starting point of the taper can be located accordingly, or consideration can be given towards employing a parallel type of right turn lane.

Although the tapered design is preferable, there will be many instances when intersection improvements are required on existing arterial streets where restricted right-of-way precludes its use. In such cases, right turn lanes added parallel to the through lanes are an acceptable alternative. The same design criteria for left

turn lanes, as shown on Exhibit D-1, may also be applied to parallel right turn lanes.

Sight Angles

The sight angle, used herein, is defined as the angle between the longitudinal axis of a vehicle in the right turn lane just before entering the stream of cross-street traffic, at the position of the driver's eye, and an approaching vehicle in the outside through lane of the cross-street. This angle varies with the curve, or combination of curves, used at the intersection and with the distance that the approaching vehicle is from the turning vehicle.

Sight angles for various combinations of distance and curves are illustrated by Sections A to E on Exhibit D-3. The lowest sight angle values are achieved in Section A. The simple radius used in this design, however, does not provide sufficient space to accommodate a curbed island. In addition, right turning vehicles entering the cross-street traffic stream are not as well guided into the outside lane as with the other examples. This design is recommended only where physical limitations prevent the use of more desirable types.

Different combinations of 3-centered compound intersection curves are used in Sections B to E. Each of these produce acceptable sight angles, with that shown in Section E considered the maximum desirable for a yield condition. The use of large compounding radii in 3-centered curves produces a natural turning path for vehicles which provides the motorist with a certain amount of freedom to accelerate and merge into the through traffic lanes, when gaps occur in the cross-street flow.

Right Turn Design Types

Exhibit D-4 illustrates four types of right turn lane designs which can

be combined to suit particular requirements and/or circumstances. All the conditions indicated are unlikely to occur simultaneously at the same intersection but have been combined on one drawing for purposes of illustration only. A brief description of each condition is as follows:

Right Turn-Stop Condition

A parallel right-turn lane is shown combined with a simple corner radius of 30 feet. As a stop sign would be installed at the intersection, it is necessary for right turning vehicles to come to a full stop before entering the cross-street. This design would be appropriate under restricted right-of-way conditions.

Right Turn - Yield Condition

The design illustrated consists of a tapered right turn lane combined with a 3-centered compound curve. Both straight faces of the island are offset 2 feet from adjacent through traffic lanes, for their full length, because of the small island size. Note that the island geometry has been adjusted to provide 2 feet of additional pavement width at the beginning of the turning roadway.

This particular example also illustrates how a far-side bus stop bay could be incorporated in the design. The length of bay depends upon the maximum number of standing buses anticipated at any one time.

Right Turn - Merge Condition

This example combines a tapered right turn exit lane with a 3-centered compound curve plus an entrance taper permitting vehicles

to merge directly into the cross-street traffic stream without stopping. Details of various merge designs are covered in Chapter H-Entrance Terminals. The larger island provided by this design permits the 2-foot approach nose offset to be tapered back to the edge of the through lane, as shown.

As with the yield condition, 2 feet of additional pavement width is provided at the beginning of the turning roadway.

The sight angle is not a controlling factor with the merge design. Therefore, a design improvement could be made, if right-of-way permitted, by utilizing a larger 3-centred curve combination, or by the use of spirals in lieu of the compounding curves.

Right Turn - Lane Away

A tapered right turn lane and a 3-centred compound curve, adequate for a speed of 25 mph, are combined with an added lane-away on the south leg of the intersecting cross-street. In this case, the angle of entry to the cross-street is very flat resulting in a sight angle unsuitable for a yield condition.

The larger island produced by the more generous turning radii permits a greater offset of the approach nose. This offset is also tapered back to the edge of the through lane, as shown. Again, additional pavement width is provided at the beginning of the turning roadway.

Advantage has also been taken of the large island size by adding a far side bus stop bay adjacent to the island itself.

Medians

Median Widths

Recommended median widths **(W)**, at locations where left turn lanes are necessary, are shown on Exhibit D-1. Although more generous values are preferred, recognition is given the fact that in certain cases restrictive right-of-way makes their use difficult, and also some jurisdictions prefer the use of gutters 1-foot wide. All widths shown provide a minimum value of 4 feet, from face to face of curbs, in the left turn bay area as this dimension is considered minimum for the safe retention of necessary signs within the median. This results in a W_1 value of 8 feet when 2-foot gutters are used, and 6 feet with 1-foot gutters. The desirable width for left turn lanes (W_2) is 12 feet, with 10 feet considered only in restrictive circumstances where the benefits derived from a left turn lane of minimum width may be preferable to no left turn lane at all. It must be understood, however, that capacity and safety factors are superior with the 12 foot width.

Introduced Median

Introduction of short lengths of median to provide protected left turn lanes are often required to relieve a capacity problem at major intersections on existing UAU streets, and where traffic projections indicate a necessity for them on new UAU streets. Since the approach nose of such medians represents a distinct hazard to oncoming vehicles, their method of introduction is a matter of critical importance.

The ideal manner of achieving street widening, necessary to introduce a median, is to widen gradually throughout the length

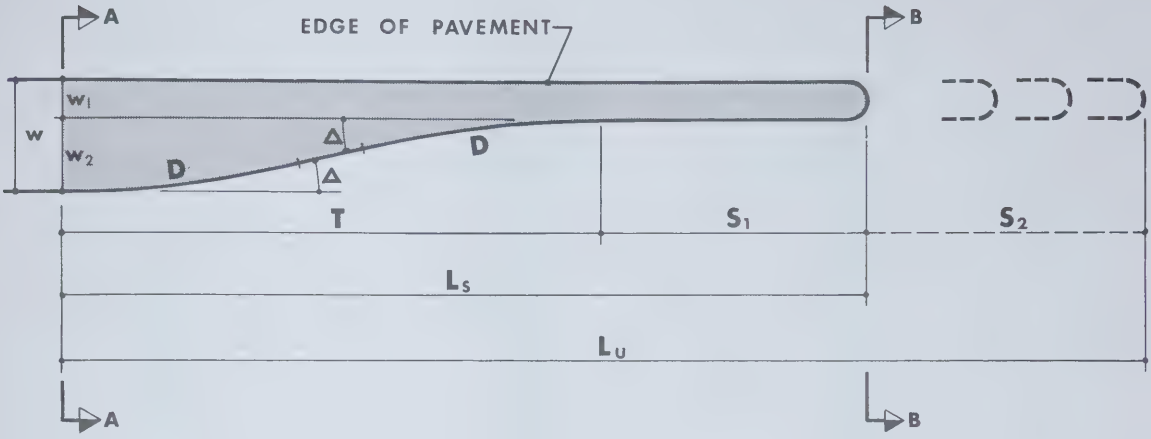
of the horizontal curve. Cases where advantage can be taken of curves for this purpose are, however, somewhat limited on UAU streets. It then becomes necessary to use other methods, some of which are shown on Exhibit D-2. The importance of using gradual tapers to effect the widening, particularly on the lanes approaching the intersection, cannot be over emphasized. Tapers of 30:1, joined to the main tangents with 1-degree curves as shown, are recommended. The degree to which this can be achieved, however, depends on individual circumstances. In general, drivers have a tendency to proceed in a straight line during the substantial part of the year in which pavement markings are virtually obliterated by winter conditions experienced in most Alberta urban centres.

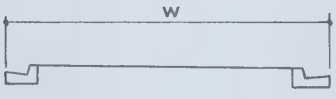
The method of median introduction depicted by Exhibit D-2 (A) represents the most desirable condition, but it can only be achieved when the centre lines of the approach roadways are offset from each other at the intersection. This is a rather rare case, occurring where the roadways are not centred within the right-of-way or, the actual rights-of-way are offset across the intersection. The introduced median width will depend entirely on the magnitude of the offset. Using this method, the median is introduced on the left side of the centre line, allowing approach traffic to continue in a straight line through the intersection. The tapering back to an undivided roadway occurs on the lanes leaving the intersection, and may be commenced at the beginning of the storage portion of the left turn lane to minimize median length.

Exhibit D-2 (B) shows the centre line continuous through the intersection, and the roadway widened equally on both sides.

In this case, the widening for the lanes, departing from the intersection, is continued beyond the widening required for the intersection approach lanes, enabling the median approach nose to to be located left of the centre line. This method results in a somewhat longer total median than that for Sections(A)and(C).

The method detailed in Exhibit D-2 (C) is a compromise which can be used where circumstances dictate a minimum total length of median. The approach nose of the median is centred on the street centre line and tapering of the lanes going away from the intersection can commence, as with Section(A), at the beginning of the left turn storage bay.





SECTION A-A

SECTION B-B

LEFT TURN BAY				
DESIGN SPEED	T	L_S MIN.	D	Δ
30	160	240	12°	6°-30'
40	200	325	8°	5°
50	250	425	5°	4°

MEDIAN WIDTHS						
	1' GUTTER (MIN. ARTERIAL STANDARD)			2' GUTTER (RECOMMENDED)		
	W	W_1	W_2	W	W_1	W_2
MIN.	16	6	10	18	8	10
DES.	18	6	12	20	8	12

T = TAPER

S_1 = STORAGE LENGTH WITH SIGNALS.

S_2 = STORAGE LENGTH WITHOUT SIGNALS.

L_S = BAY LENGTH FOR SIGNALIZED INTERSECTIONS.

L_U = BAY LENGTH FOR UNSIGNALIZED INTERSECTIONS.

SIGNALIZED INTERSECTION: $L_S = T + S_1$ OR $L_{S\,MIN.}$

UNSIGNALIZED INTERSECTION : $L_U = L_{S\,MIN.} + S_2$

EXAMPLE: FIND Ls or Lu FOR 30 M.P.H.
GIVEN: STORAGE LENGTH BASED ON TRAFFIC REQUIRMENTS.
(a) 60' WITH SIGNALS
(b) 100' WITH SIGNALS
(c) 100' WITHOUT SIGNALS
SOLUTION: (a) Ls = 160+60=220 (USE 240 MIN.)
(b) Ls = 160+100=260 (USE 260)
(c) Lu = 240+100=340

NOTES:
1. CRITERIA MAY ALSO BE USED FOR RIGHT TURN LANE.
2. VALUES FOR T, D AND Δ BASED ON DESIRABLE 'W' DIMENSIONS.

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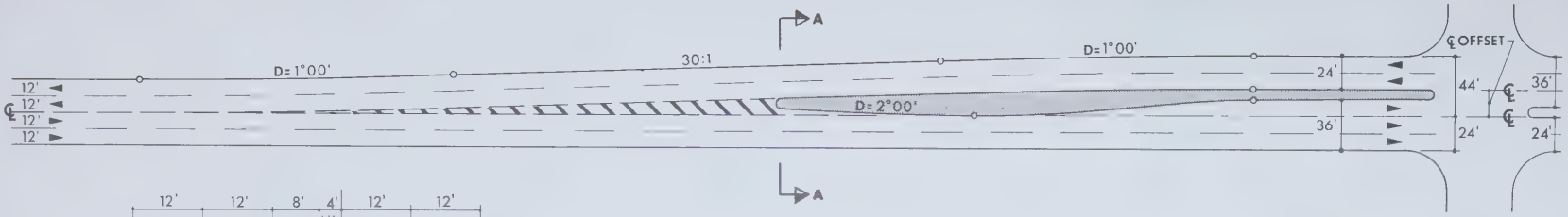
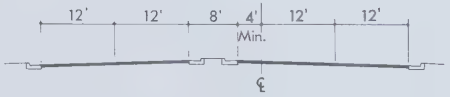
MEDIAN DESIGN
LEFT TURN BAY



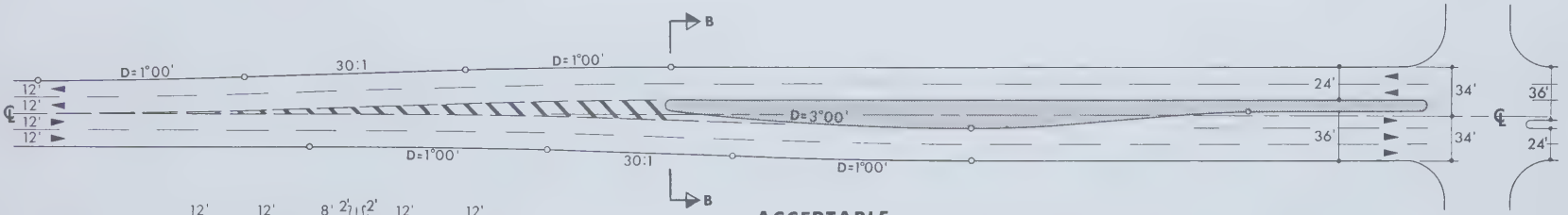


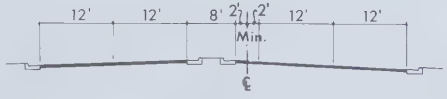
SECTION A-A

DESIRABLE

MEDIAN-OFFSET FROM CENTRE LINE

(A)





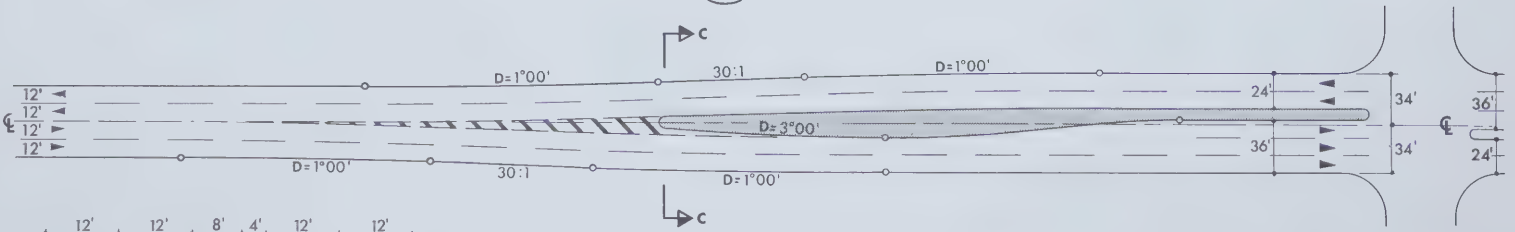
SECTION B-B

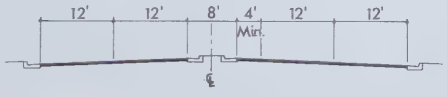
ACCEPTABLE

MEDIAN-SPLIT ON CENTRE LINF

APPROACH NOSE OFFSET FROM ℄

(B)





SECTION C-C

MINIMUM

MEDIAN-SPLIT ON CENTRE LINE

APPROACH NOSE ON ℄

(C)

NOTE:
LEFT TURN LANES AS
PER EXHIBIT D-1

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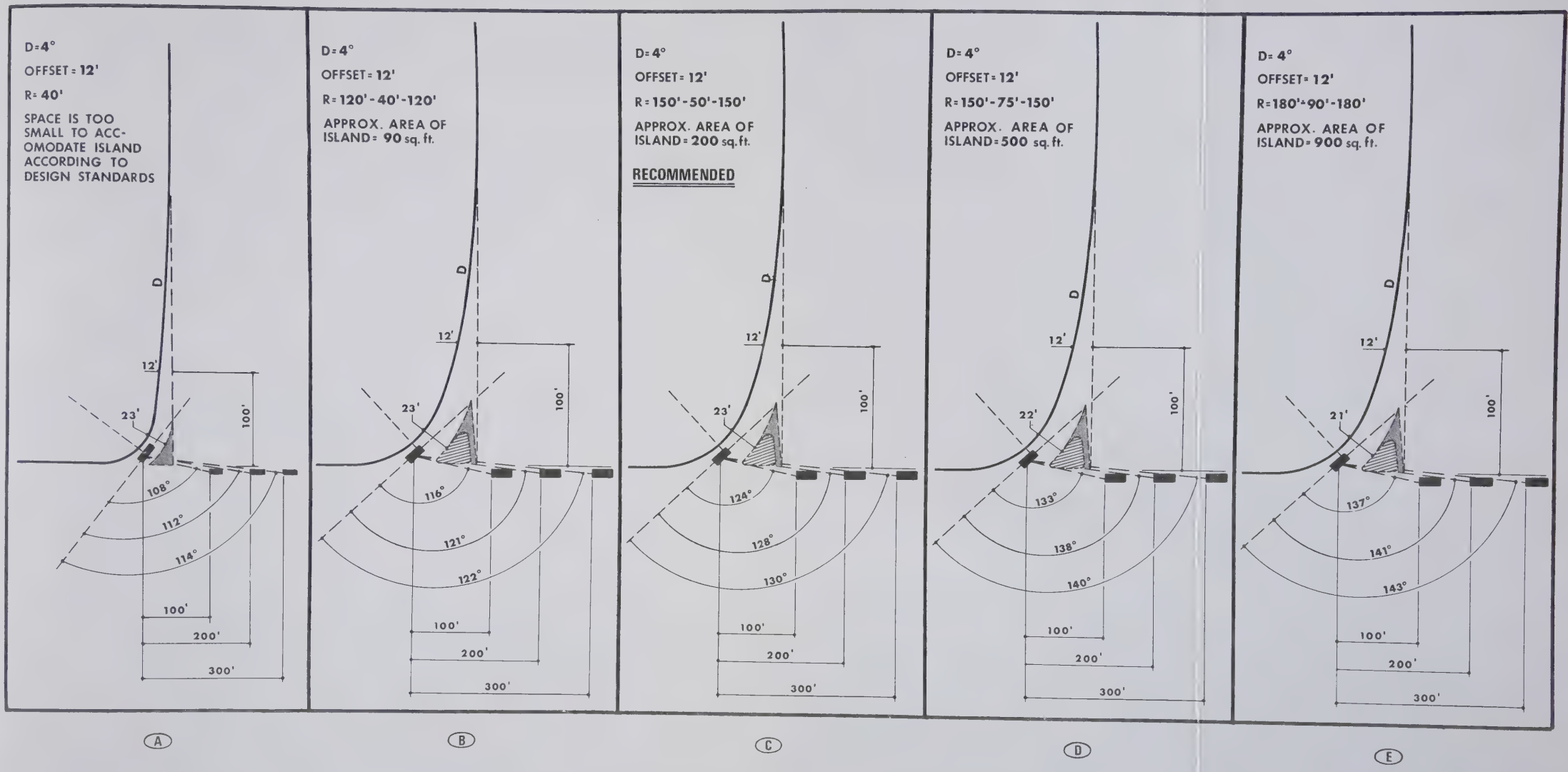
INTRODUCED MEDIAN

EXHIBIT D-2



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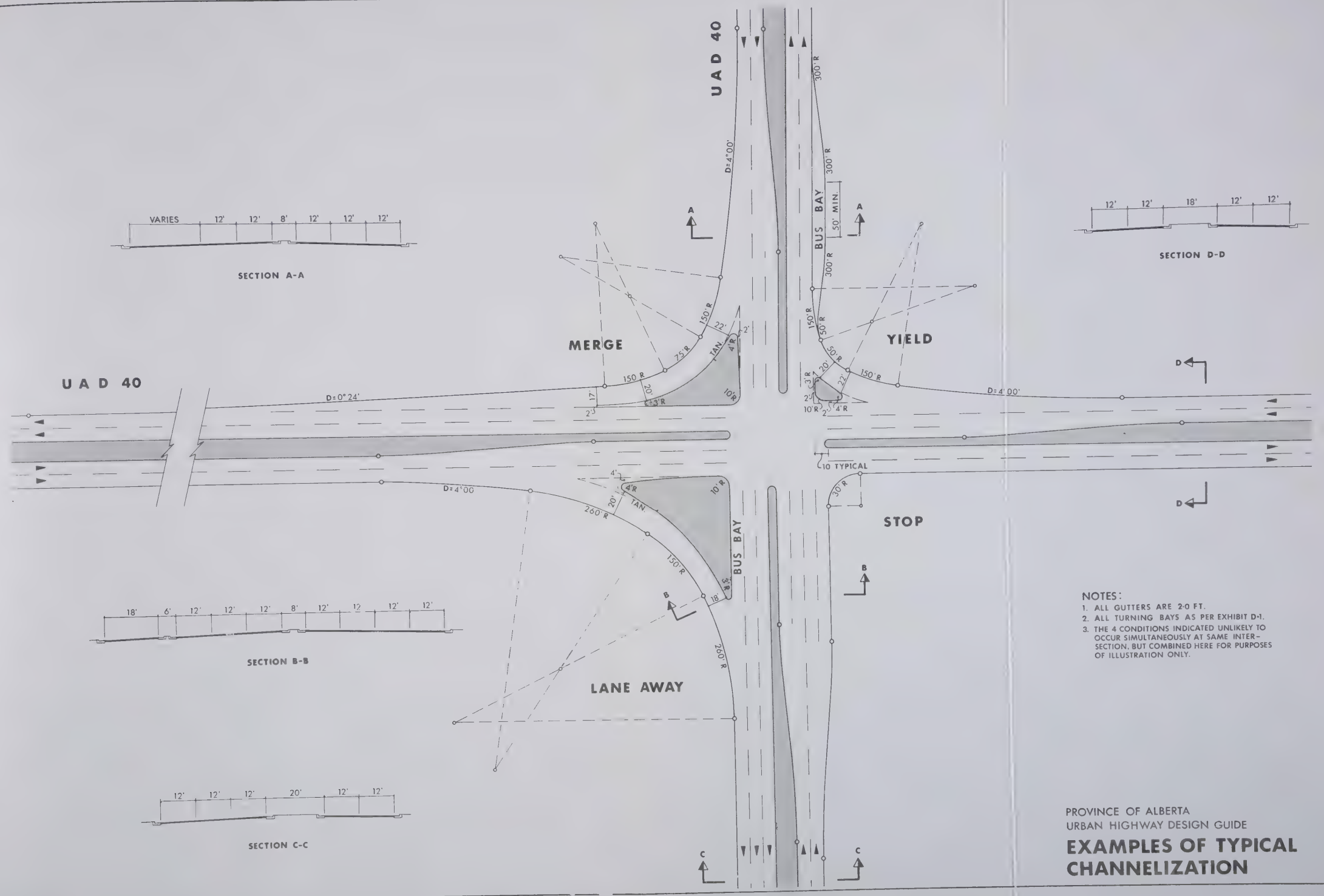
RIGHT TURN
SIGHT ANGLE



NOTES:
1. ALL GUTTERS ARE 2·0 FT.
2. ALL TURNING BAYS AS PER EXHIBIT D-1.
3. THE 4 CONDITIONS INDICATED UNLIKELY TO OCCUR SIMULTANEOUSLY AT SAME INTER-SECTION, BUT COMBINED HERE FOR PURPOSES OF ILLUSTRATION ONLY.

PROVINCE OF ALBERTA
URBAN HIGHWAY DESIGN GUIDE

EXAMPLES OF TYPICAL CHANNELIZATION

CHAPTER · E

TYPICAL SECTIONS

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CHAPTER · E

TYPICAL SECTIONS

Cross-sectional elements, in conjunction with horizontal and vertical alignment, are major factors which determine the capacity and safety of freeways and arterial streets. Lane and shoulder widths, horizontal clearances - from edge of travelled way to structural piers and other obstructions, guardrail placement, excavation and embankment side slope ratios are among the agents to be considered in cross-section design. All of these elements have been combined, showing recommended minimum dimensions, in Exhibits E-1 through E-4.

Freeways

Typical freeway cross-sections are illustrated on Exhibit E-1. Section (A) represents a basic freeway; Section (B) shows the right half-section of a freeway with a parallel collector-distributor road; Section (C) indicates a depressed median treatment that may be used where future addition to the number of travelled lanes may be necessary, or where extent of right-of-way makes possible the design of a median greater than minimum width.

Travel Lanes

A minimum of 4-travel lanes is considered to be the smallest number of lanes feasible for an urban type of freeway. With lane widths of 12 feet, this results in a minimum roadway width of 24 feet for each direction of travel. If additional lanes are required, the basic roadway widths are then increased by multiples of 12 feet.

Shoulders

Freeways, because of their high volume, high speed and free flowing characteristics necessary to justify the capital expenditures involved, require the provision of full shoulders to accommodate the temporary storage of disabled and maintenance vehicles. Shoulders must be of such width that vehicles within them will not unduly hinder operation of the adjacent travel lanes. For this purpose a minimum right shoulder width of 8 feet plus a 2-foot gutter, giving a total horizontal clearance of 10 feet between the outer edge of travelled way and the curb face, is required. A minimum left shoulder width of 6 feet plus a 2-foot gutter, equal to an overall horizontal clearance of 8 feet, is considered adequate since drivers are seated on this side of the vehicle and are better able to judge left side clearances. When it is anticipated that a large percentage of the total traffic volume, using a proposed freeway facility, will be comprised of trucks and expressway type buses a more desirable standard for left and right shoulders would be 8 and 10 feet respectively. This results in left and right horizontal clearances of 10 and 12 feet, being measured between the outer edge of travelled way and the face of curb.

Medians

Narrow medians are comprised of adjacent shoulders, gutters, plus the raised center portion between curbs. On a basic freeway section, Exhibit E-1(A), the minimum median width of 28 feet is made up of the two 6-foot shoulders, two 2-foot gutters and a raised portion of 12 feet. A continuous median barrier is required on narrow medians of this type to prevent disastrous cross-median accidents. If a double steel flex-beam barrier is used, the 12-foot raised portion of a median provides a clearance of 4.73 feet from face of barrier to curb face.

Overpass structures are normally located at frequent intervals on urban freeways. At these locations it is advantageous to locate the support piers within the median. In this way motorists can be protected, from the possibility of colliding with the pier, by the use of a continuous median barrier. If piers are located on the right side of the roadway, it is necessary to introduce short lengths of guardrail for this purpose. A more acceptable width of median, in order to properly incorporate piers, is 32 feet, giving a raised portion of 16 feet. A pier width of up to 4 feet could then be accommodated, leaving sufficient space to locate the face of box beam guardrail 2 feet from face of curb and allow a recommended dimension of 4 feet from face of rail to face of pier. This permits maximum deflection of the box beam, upon impact, without penetrating the pier. Additional information on guardrail clearances is discussed in Chapter F.

Because the median between a freeway and a parallel collector-distributor road incorporates an 8-foot right freeway shoulder, the minimum median width must be increased by 2 feet as indicated in Exhibit E-1(B).

Wherever traffic volume projections indicate the necessity of increasing the number of basic freeway lanes at a future date, it is advantageous to provide sufficient width within the median for that purpose. Roadway widening into the median eliminates costly reconstruction of the numerous ramp terminals which inevitably occur on urban freeways. The median width in these cases would then be the desirable minimum plus multiples of 24 feet; the provision for 1 or 2 future lanes on each side results in median widths of 56 and 80 feet respectively. If medians of these widths are used, it is considered unnecessary to install continuous median barriers. A depressed grassed median of the type shown in Exhibit E-1(C) can then be used. Although curbs are not shown on this illustration, some jurisdictions may prefer their use. Surface drainage can be collected by catch basins, spaced at appropriate intervals, along the bottom of the median depression.

Luminaire Supports

As with any fixed object projecting above ground level within urban freeway rights-of-way, every effort should be made to locate street lighting as far from the edge of the outer lane pavement as possible. A minimum of 30 feet should be used wherever it can be achieved. Where the freeway is to be constructed through an already built up urban area, however, attainment of the 30-foot desirable minimum offset may not always be possible. Exhibit E-1(A) shows an offset of 18.5 feet from edge of travelled lanes to face of luminaire support and this should be considered an absolute minimum.

Side Slopes

Excavation and embankment side slopes should be kept as flat as available right-of-way will permit, with a horizontal to vertical ratio of 3:1 considered a practical maximum. Not only are gentle side slopes and generous roundings aesthetically pleasing, they are a logical alternative to installation of guardrail on high embankments. Most out-of-control vehicles are able to negotiate a 6:1 side slope without damage. Depressed medians with earth slopes of 6:1 or flatter, and having 20-foot wide roundings, also provide an acceptable design for similar reasons.

Underpass Structures

Exhibit E-2(A) shows a typical freeway section through an underpass structure. All elements of roadway width are maintained as on open sections, with the exception of the continous median guardrail. It is separated and flared out to clear the curb face by a minimum of 1-foot (box beam) or 2 feet (flex beam) in the area of the structural pier. Similarily, if support piers are located on the outside edges of the roadways, guardrail is introduced being offset a minimum of 1-foot from the curb face. While a 3:1 side slope ratio beneath the underpass structure itself is desirable, in conveying a sense of openness, it is nevertheless difficult to justify the extra structural expenditure involved. Therefore, a ratio of 2:1 has been established as an acceptable minimum standard. Roundings of 20 feet, starting at the curb line, are also recommended.

Overpass Structures

As with underpass structures full roadway widths are maintained across overpass structures indicated by Exhibit E-2(B). A 1-foot clearance is provided between the parapet and curb faces, which lines up the parapet with the guardrail on the structure approach embankments.

Retaining Walls

Examples of conditions where retaining walls may be necessary are illustrated by Exhibit E-2(C), (D) and (E). Section (C) shows the freeway in an excavated area; Section (D) indicates an embankment condition. In both cases a minimum distance of 1-foot is maintained between the face of curb and face of wall. Section (E) illustrates a case where the freeway and a parallel collector-distributor road are at different elevations. Although the clearance from curb to parapet on the freeway is shown as 1-foot, designers must use discretion as to whether the wall should be centrally located between curbs.

Ramps

Ramp widths are considered in detail in the section "Ramp Widths" (Page E.11) as well as Chapters G and H - Exit and Entrance Terminals. Exhibit E-3 shows freeway ramp cross-sections appropriate for various circumstances. When a ramp is carried through an underpass, as shown by Section (A), recommended left and right side clearances, measured from edge of travelled way to pier face, are 9 and 13 feet respectively. Section (B) illustrates a UFD Left Turning Ramp while Section (C) indicates a UFD Right Turning Ramp. Note, particularly, that luminaire supports are always located on the inside of curvature. The recommended minimum distance from outside edge of ramp shoulder to the face of luminaire support is 10.5 feet. In all cases where guardrail is used, the distance between curb and rail faces is 1-foot.

Exhibit E-3(D) and (E) illustrate suggested treatments for adjacent ramps at different elevations where restrictive right-of-way makes it necessary to take up the elevation difference by means of a retaining wall. In both cases, it is essential to check for adequacy of horizontal sight distance as described in Chapter B. Section (D) is of two ramps in the same direction while Section (E) indicates two ramps in opposite directions. The latter case frequently occurs between a loop ramp and an outer ramp, as shown by the sketch. Here a minimum distance of 11 feet between edges of ramp lanes is possible, subject of course, to the sight distance check. The standard lateral clearance of 1-foot between curb and parapet faces is provided on ramp overpasses, as indicated by Section (F). On curving ramp structures it is essential that adequate horizontal sight distance, in accordance with Chapter B, be maintained. Such a prerequisite may, at times, require the ramp shoulder width to be increased accordingly.

Recent experience in Alberta indicates that drivers are using the right shoulder of loop ramps as part of the travelled way, despite paint line or surface treatment delineation of the shoulder area. This driver behaviour may indicate a warrant for relocating the shoulder to the left side of the ramp. Further research into this area is required.

Arterial Streets

Basic cross-sections applicable to arterial streets are illustrated on Exhibit E-4. Examples are given of both UAD (Urban Arterial Divided) and UAU (Urban Arterial Undivided) sections.

Travel Lanes

As with freeways, a 12-foot lane width is recommended for arterial streets; also two travel lanes per direction is considered the minimum number feasible. This results in a minimum pavement width of 48 feet for undivided arterials and two 24-foot pavement widths for divided arterials. These basic dimensions are increased by multiples of 12 feet and 24 feet, on divided and undivided arterials respectively, as additional lanes become necessary.

Shoulders

Shoulders are not usually considered necessary on arterial streets. The same freedom of operation as freeways provide is not expected, and the relatively close spacing of intersections provide more opportunity for disabled vehicles to leave the through lanes. In some cases, particularly with higher design speeds, intersections may be at such wide spacing that it is wise to provide a grassed shoulder outside a mountable curb.

Medians

The recommended median widths, discussed in Chapter D-Arterial Streets, are illustrated on the various cross-sections of Exhibit E-4. When intersections, requiring left turn bays, are widely spaced in deep cut sections or across high embankments in conjunction with long structures, economic considerations and/or right-of-way restrictions may, in special circumstances, dictate use of a narrower median. Great care must be exercised to design median

width transitions with very gradual tapers; ideally this should be done on curves. The minimum median width considered is 8 feet, with 10 feet a desirable minimum. Such a minimum median is shown on Exhibit E-4(F). This section also illustrates the use of a New Jersey, or other precast concrete type of barrier in uncurbed narrow medians. Section (G) shows a left turn bay incorporated in the desirable standard 20-foot wide median.

Sidewalks

Sidewalks are frequently necessary on arterial streets, particularly those designed for lower speed operation. Exhibit E-4 (A) to (E) shows recommended sidewalk locations for various circumstances. Under usual conditions [Section (D) and (E)] the sidewalk is separated from the curb by a boulevard which should be as wide as available right-of-way will permit. A boulevard width of 10 feet is considered a practical minimum for pedestrian safety. Lesser width increases the possibility of vehicle constraint, pedestrians being splashed and children being pushed into the path of vehicles. Sidewalk widths normally depend on a predicted pedestrian volume, with the exception of sidewalks on overpass where a minimum width of 6 feet is desirable, Sections (B) and (C). If pedestrian volumes are expected to be more than minimal, consideration should be given to providing sufficient width on overpass structures to install a barrier between the sidewalk and the roadway. Such a barrier would be subject to the standard lateral clearance measured from edge of pavement.

Luminaire Supports

When sidewalks form part of a street cross-section, luminaire supports should be located at the back of sidewalk, as indicated by Sections (D) and (E). If sidewalks are not provided, a clearance of 8.5 feet from pavement edge to pole face is considered a practical minimum, with a greater offset desirable.

Underpass Structures

The recommended minimum clearance from outside pavement edge to face of supporting piers is 6 feet. If the minimum clearance is used, sidewalks are to be situated outside the piers, in accordance with Exhibit E-4(A). Where a supporting pier is located in the median, a minimum median width of 16 feet between pavement edges is required to provide the necessary clearances (assuming a pier width of 4 feet). In order to blend underpass side slopes more satisfactorily with the general grading pattern of arterial streets and provide an aesthetically pleasing design a side slope ratio of 3:1 is desirable. As previously stated, due to the extra structural expenditure involved, a ratio of 2:1 has been established as an acceptable minimum standard.

Overpass Structures

Cross-sections through overpass structures are shown on Exhibit E-4(B) and (C) for undivided and divided arterial streets respectively. While the full width of the roadways and median are normally carried across the structure, for purposes of economy, the boulevard separating vehicular and pedestrian traffic has been eliminated. In cases where a sidewalk is not required, a mini-

mum lateral clearance of 5 feet from edge of pavement to face of parapet is recommended. [Section (B)].

Ramps

A typical ramp for an interchange between two arterial streets is shown by Exhibit E-4(H). Basic pavement widths are described in Chapters G and H, Exit and Entrance Terminals, as well as in the Ramp Width section, below. As with freeway ramps, street lighting should always be located on the inside of curves, and the minimum lateral clearance for placement of luminaire supports on arterial streets will apply to arterial ramps as well. Guardrail placement should provide the 5-foot lateral clearance from edge of ramp pavement.

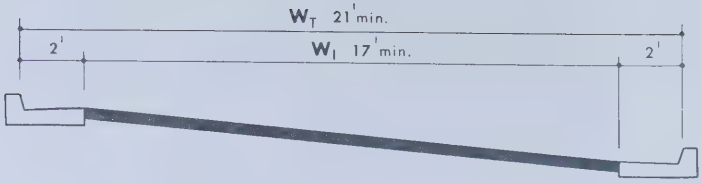
Ramp Widths

The information in this section applies only to the portion of ramps having a constant width. The reader is referred to Chapters G (Exit Terminals), H (Entrance Terminals) and I (Loop Ramp Design) for information on ramp widths within transition areas.

There are two main ramp categories:

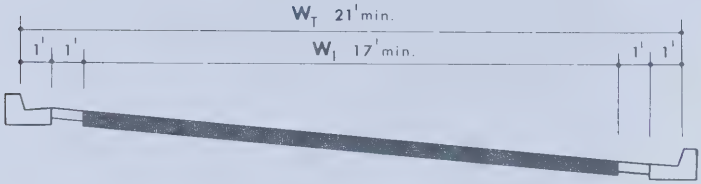
1. UAD Ramps, as shown in Figure E-1, have no shoulders and are used to interchange between UAD streets which also have no shoulders.

2. UFD Ramps, as shown in Figure E-2, have shoulders and are used to interchange between highways when either one or both of the intersecting roadways contain shoulders.



UAD RAMP - 2' GUTTER

(A)



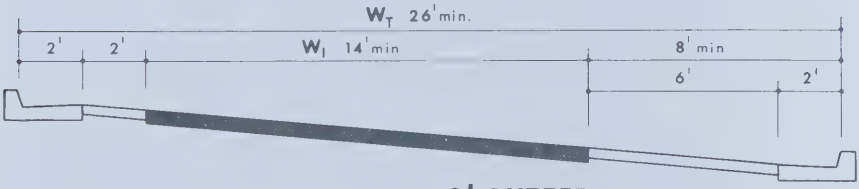
UAD RAMP - 1' GUTTER

(B)

NOTE:
W_T - TOTAL WIDTH OF RAMP, CURB TO CURB
W_1 - DRIVING AREA

FIGURE E-1

It is important to note that if a ramp either exits from, or enters onto a freeway, then that ramp will be of a UFD type throughout its entire length.



UFD RAMP - 2' GUTTER

NOTE:
W_T - TOTAL WIDTH OF RAMP, CURB TO CURB
W_1 - DRIVING AREA

FIGURE E-2

The recommended design criteria dealing with ramp widths is based on Table VII-7 of AASHO, as follows:

Case II: 1-lane, one-way operation with provision for passing a stalled vehicle.

Case III: 2-lane operation, one-way.

TRAFFIC CONDITION **B** - Sufficient SU vehicles to govern design, but some consideration for semi-trailer vehicles.

TRAFFIC CONDITION **C** - Sufficient semi-trailer WB-40 or WB-50 vehicles to govern design.

NOTE: No consideration was given to Case I (1-lane, one-way, no passing) or Traffic Condition A (Predominantly P vehicles with some consideration to SU trucks) as these conditions were not deemed to be compatible with urban conditions.

The dimensions shown in Table VII-7 AASHO are considered to be curb face to curb face, and it has been further assumed that all urban ramps will incorporate barrier or mountable type curbs with 1 or 2-foot gutters. Gutters are considered part of the total horizontal clearance.

All width adjustments pertaining to edge of pavement treatment and minimum pavement widths are as per the above-mentioned Table.

It should be noted that where the designer encounters specific situations that deviate from the conditions assumed herein, AASHO should be used directly.

E.14 UAD RAMPS:

Tables E-1 and E-2 indicate recommended UAD ramp widths for various degrees and curve radii.

TABLE E-1

(UAD, 1-LANE RAMP, CASE II ONLY)

R or **D** Inner Edge of Pavement Curvature	Traffic Condition		Recommended Total Width (W_T) (Curb face to Curb face)
	B	**C**	
50'	26'	30'	27'
75'	24'	28'	26'
100'	23'	26'	25'
38°	22'	25'	24'
24°	22'	24'	23'
18°	21'	23'	22'
12°	21'	23'	22'
Tan.	20'	22'	21'

Notes -

1. Values of **B** & **C** have been adjusted for barrier curbs on both sides.

2. The recommended 1-lane total width (W_T) values represent a compromise between Traffic Conditions **B** and **C**. Where the designer knows beforehand that a ramp will definitely operate under Traffic Conditions **B** or **C**, then the values indicated for **B** or **C** can be used.

TABLE E-2

(UAD, 2-LANE RAMP, CASE III ONLY)

R or **D** Inner Edge of Pavement Curvature	Traffic Condition		Recommended Total Width (W_T) (Curb face to Curb face).
	B	**C**	
50'	37'	44'	40'
75'	35'	39'	37'
100'	33'	37'	35'
38°	32'	35'	33'
24°	31'	33'	32'
18°	30'	32'	31'
12°	30'	31'	30'
Tan.	29'	29'	28'

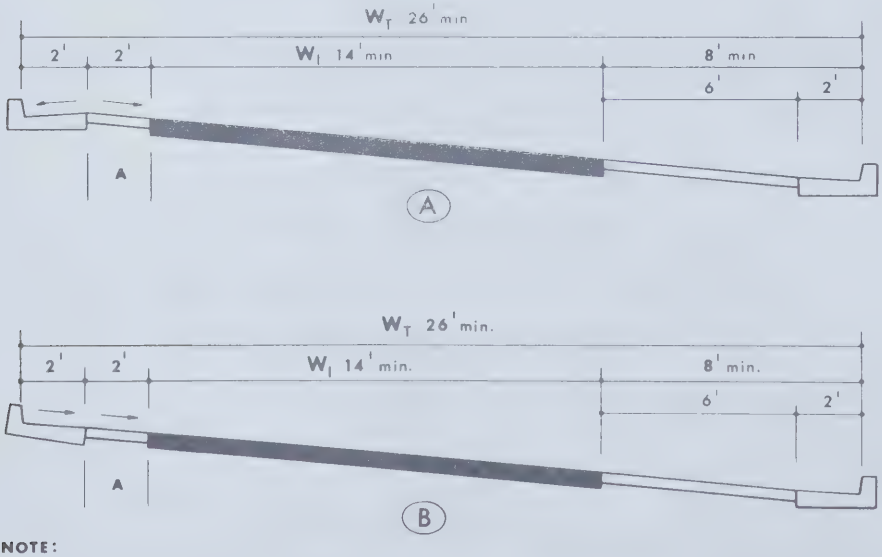
Notes - 1. Values of **B** & **C** have been adjusted for barrier curbs on both sides.

2. The recommended 2-lane total width (W_T) values represent a compromise between Traffic Conditions **B** and **C**.

UFD RAMPS:

In establishing widths for UFD ramps, it was assumed that this class of ramp would utilize minimum left and right shoulder widths of 2 and 6 feet respectively plus 2-foot gutters.

Figures E-3(A) and (B) indicate alternate methods of treating the left shoulder, depending upon whether a "standard" or "reverse" gutter section is used.



NOTE:
W_T - TOTAL WIDTH OF RAMP, CURB TO CURB
W_l - DRIVING AREA

FIGURE E-3

Notes: 1. It is assumed that all gutters on UFD ramps are 2 feet wide.

2. Figure E-3(A) indicates a standard gutter section at the left shoulder. While this arrangement helps reduce the amount of water crossing the super-elevated pavement under freeze-thaw conditions, it does result in a 0.16 "roll over" at the edge of the gutter. However, if area "A" is of contrasting pavement, and is well delineated, vehicles should not deviate from the ramp proper. In the event that the gutter area must be traversed in order to pass a stalled vehicle, the speed will probably be low, and no problem due to roll over should be encountered.

3. Figure E-3(B) indicates a reversed gutter section at the left shoulder. Although this eliminates the roll over problem, it necessitates transitions from standard to reverse gutter sections, and is not effective in reducing the flow of water across the pavement. While still desirable to have area "A" of contrasting pavement, consideration could be given to extending the asphaltic surface to the edge of the gutter, providing that the 2-foot shoulder line is adequately delineated by paint and/or seal coat.

Tables E-3 and E-4 indicate recommended UFD ramp widths for various degrees and curve radii.

TABLE E-3

(UFD, 1-LANE RAMP, CASE 11 ONLY)

R or **D** Inner Edge of Pavement Curvature	Traffic Condition		Recommended Travelled Pavement Width (W_1)
	B	**C**	
100'	16'	18'	14'
38°	16'	17'	14'
24°	16'	17'	14'
18°	16'	16'	14'
12°	15'	16'	14'
Tan.	15'	15'	14'

Note: The values indicated in the **B** & **C** columns are the minimum widths required as per Table VII-7 AASHO. For simplicity, and considering the extra width provided by the recommended 2-foot left hand shoulder, all pavement widths for UFD 1-lane ramps have been shown as 14 feet (W_1).

This width, combined with the left and right hand shoulder widths provides adequate passing standards for practically all situations likely to be encountered under Case II conditions.

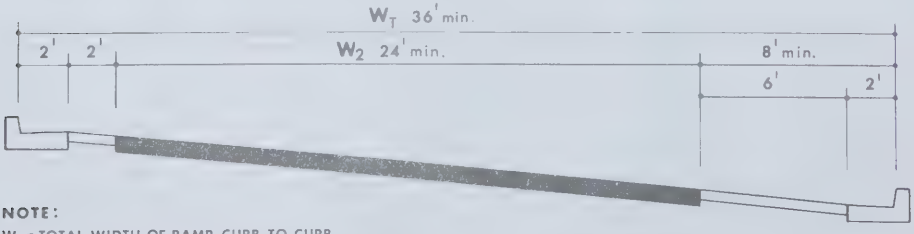
TABLE E-4

(UFD, 2-LANE RAMP, CASE III ONLY)

R or D Inner Edge of Pavement Curvature	Traffic Condition B	Traffic Condition C	Recommended Travelled Pavement Width (W_2)
100'	30'	34'	30'
38°	29'	32'	28'
24°	28'	30'	26'
18°	27'	29'	26'
12°	27'	28'	26'
Tan.	26'	26'	24'

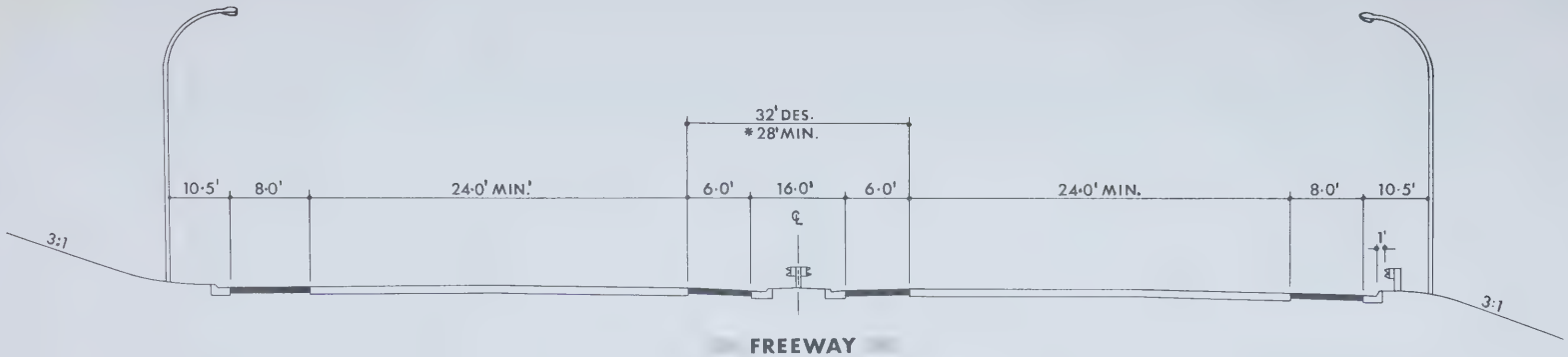
Note: The values indicated in the **B** and **C** columns are the minimum widths required as per Table VII-7, AASHO. The recommended pavement widths (W_2) were established by placing emphasis on Traffic Condition **C**, in order that the wider lanes would encourage proper 2-lane operation. The extra width provided by the left hand shoulder should also aid in free operation.

Figure E-4 indicates the recommended cross-section for Case III, 2-lane, one-way UFD ramp. Again, a reverse left gutter is an acceptable alternative.



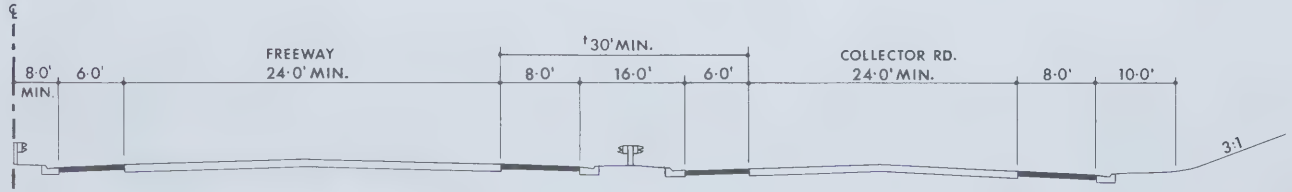
NOTE:
W_T - TOTAL WIDTH OF RAMP, CURB TO CURB
W_2 - DRIVING AREA

FIGURE E-4



FREEWAY

(A)



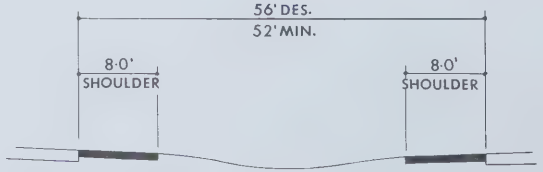
RIGHT HALF OF FREEWAY WITH C-D ROAD

(B)

NOTE

* SEE EXHIBIT F-5.

† MINIMUM COLLECTOR MEDIAN IS 2' WIDER THAN FREEWAY MEDIAN DUE TO 8' SHOULDER ON RIGHT SIDE OF FREEWAY.



DEPRESSED MEDIAN

(C)

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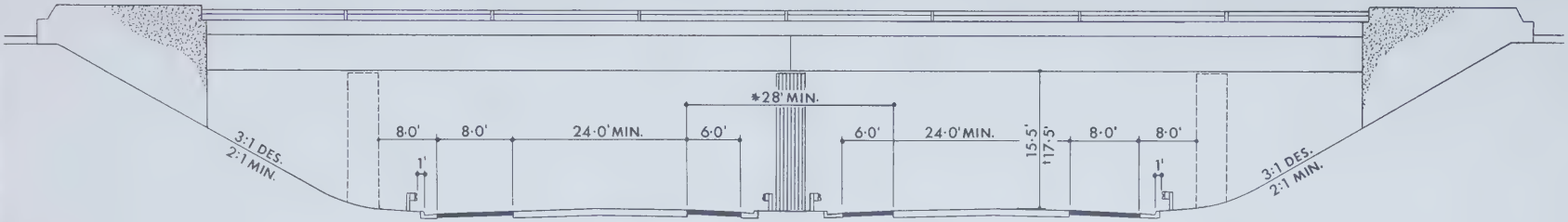
TYPICAL SECTIONS
FREEWAYS

EXHIBIT E-1

PROVINCE OF ALBERTA
URBAN HIGHWAY DESIGN GUIDE

TYPICAL SECTIONS–FREEWAYS

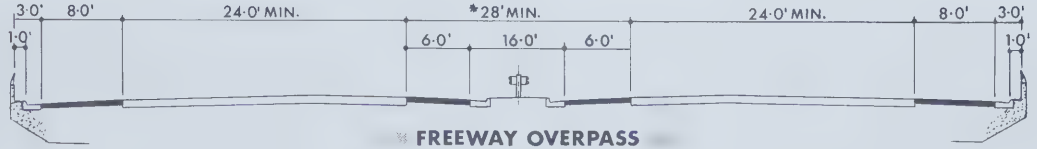
STRUCTURES & RETAINING WALLS



FREEWAY UNDERPASS

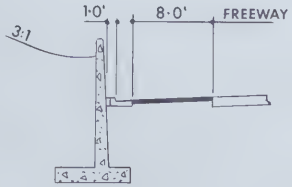
(A)

* SEE EXHIBIT F-5
† HIGH LOAD ROUTE

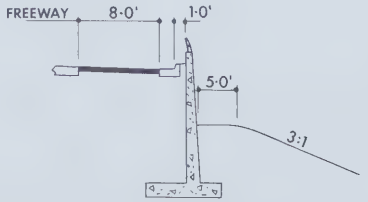


FREEWAY OVERPASS

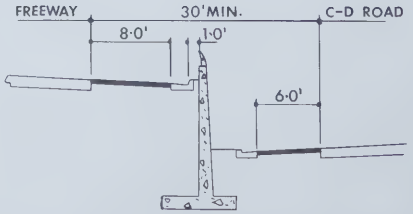
(B)



(C)



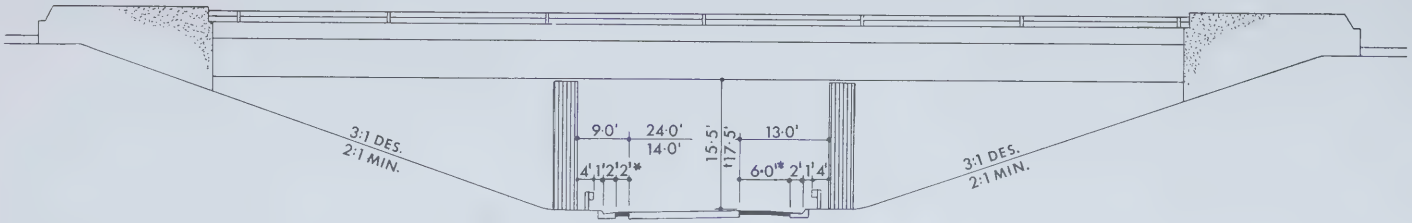
(D)



(E)

RETAINING WALLS

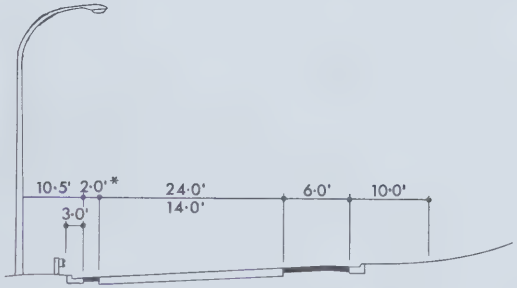
EXHIBIT E-2



* HIGH LOAD ROUTE

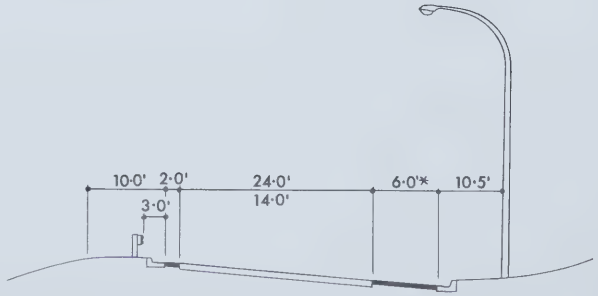
ONE OR TWO LANE UNDERPASS

(A)



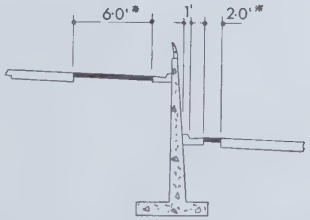
LEFT TURNING RAMP

(B)



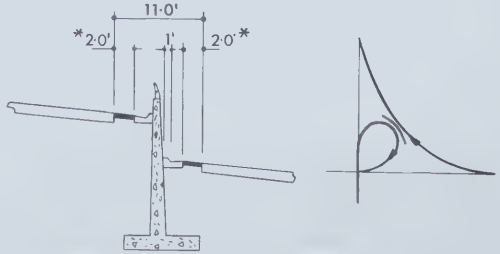
RIGHT TURNING RAMP

(C)



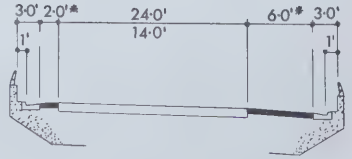
(D)

RETAINING WALLS



OPPOSING RAMPS

(E)



ONE OR TWO LANE OVERPASS

(F)

*SHOULDER DIMENSIONS ARE MINIMUM HORIZONTAL SIGHT DISTANCE CONTROLS

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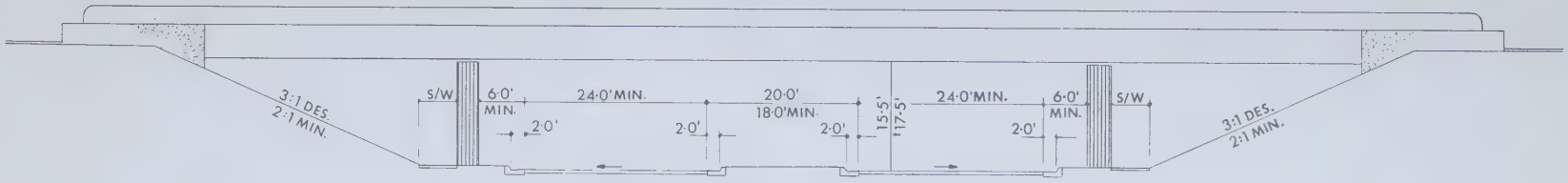
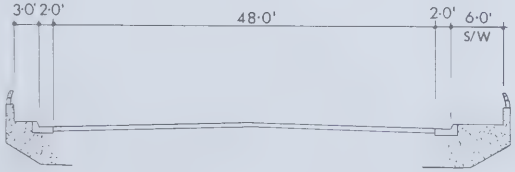
TYPICAL SECTIONS
U.F.D. RAMPS

EXHIBIT E-3



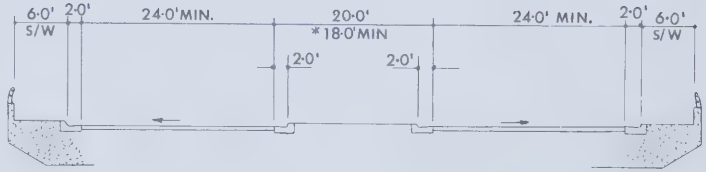
DIVIDED UNDERPASS † HIGH LOAD ROUTE

(A)



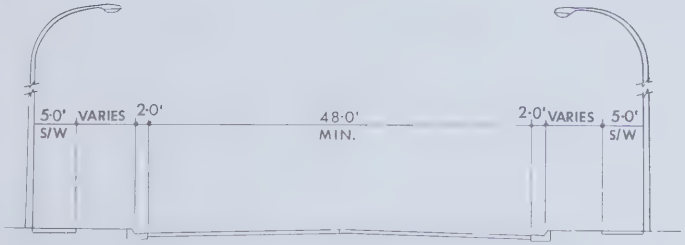
UNDIVIDED OVERPASS

(B)



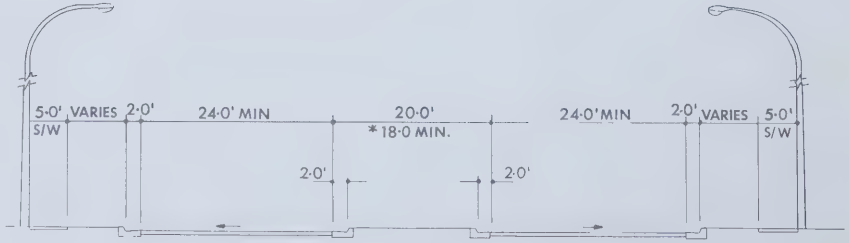
DIVIDED OVERPASS

(C)



UNDIVIDED

(D)

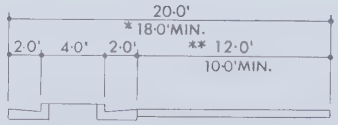


DIVIDED

(E)

MINIMUM MEDIAN

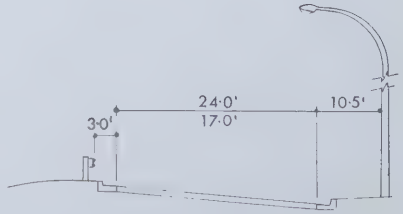
(F)



MEDIAN

(G)

*18·0'MIN. MEDIAN BASED ON USE OF 2' GUTTER. IF 1' GUTTER UTILIZED SEE EXHIBIT D-1.
**LEFT TURN BAY.



RAMP

(H)

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TYPICAL SECTIONS
ARTERIAL STREETS

EXHIBIT E-4

CHAPTER · F

GUARDRAIL

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CHAPTER · F

GUARDRAIL

Warrants

Guardrail, by providing protection for vehicles from bridge abutments, piers, parapets, high fills and other roadside obstacles, plays a very important role in highway safety. Guardrail may be defined as a highway appurtenance which, if properly located and installed, will, upon impact, redirect an errant vehicle from a dangerous path.

Unfortunately, guardrail installations themselves,even when properly designed and located, still become a formidable highway hazard and, as such, their use should be avoided whenever possible. Side slopes should be flattened and other roadside features designed to reduce the need for guardrail wherever possible.

Generally speaking, guardrail may be required for any one of a combination of the following conditions:

(1) Highways on embankments, especially high fills with steep side slopes;

(2) Divided highways carrying large volumes of traffic separated by a narrow median;

(3) Highways containing laneside obstacles and hazards such as structural piers and bodies of water.

The following sections deal with each of the above conditions in turn, and guide lines are presented which provide the designer with a rational method of establishing warrants for the installation of guardrail for any given situation.

Guardrail Determination for Embankment Conditions

As a general rule, guardrail is required on primary highways where the fill height exceeds 15 feet with a side slope ratio of 3:1. There are, however, other factors concerning roadside conditions which may determine whether or not a particular guardrail installation is warranted. In order to quantify these factors, a "Need Index" for guardrail installation has been developed. Table F-1 indicates the basic Need Index Values for Embankment Conditions, while Table F-2 lists adjustment factors which must be applied to Table F-1 to compensate for the following special conditions:

(1) Shoulder Width
(2) Horizontal Curvature
(3) Downgrade or Profile Conditions
(4) Roadside Conditions
(5) Climatic Conditions

In the determination of guardrail requirements on existing highways, accident experience at specific sections may be the determining warrant in addition to those of Table F-2.

TABLE F-1

GUARDRAIL NEED INDEX

Basic Values for Embankment Conditions *

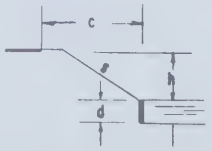
Height of Fill, **h**, in Feet	1 1/2:1	2:1	2 1/2:1	3:1	4:1
4	40	35	30	25	10
6	45	40	35	30	15
8	50	45	40	35	20
10	55	50	45	40	25
12	60	55	50	45	30
15	65	60	55	50	35
20	70	65	60	55	40
30	75	70	65	60	45
40 or more	80	75	70	65	50

* Need Index for precipitious condition: General-relatively great drop = 80
Critical-with high level view = 100

TABLE F-2

ADJUSTMENT FACTORS TO BE APPLIED TO BASIC VALUES OF GUARDRAIL NEED INDEX

ITEM	FACTOR
SHOULDER WIDTH, OVERALL - feet	
12-15	1.00
10	1.05
8	1.10
6	1.15
HORIZONTAL CURVATURE (As related to design speed)	
Tanget or flat curve	1.00
Intermediate curve	1.05
Inside curve	
-Min. or near min., or isolated intermediate curve	1.10
-Isolated min. or near min. curve, or curves over 10°	1.15
Outside Curve	
-Min. or near min., or isolated intermediate curve	1.20
-Isolated min. or near min. curve, or curves over 10°	1.25
DOWNGRADE OR PROFILE CONDITIONS	
2% or less	1.00
3%	1.05
4%, or moderate crest V.C. in comb. with horiz. curve	1.10
5%	1.15
6%, or extreme crest V.C. in comb. with horiz. curve	1.20
7% or more	1.25
ROADSIDE CONDITIONS	
Ground sloping away from toe of fill at the rate of: (1)	
10% or less	1.00
15%	1.10
20%	1.15
25% or more	1.20
Boulders on slope, or road or building at toe of slope (1)	1.20
Wall at toe of slope:	
Add 5x**d** to height of fill, **h**, and enter Table F-1 with the larger equivalent **h** for the **s** indicated.	
Water at toe of slope:	
Add 8x**d** to height of fill, and enter Table F-1 with the larger equivalent **h** for the **s** indicated.	
CLIMATIC CONDITIONS (2)	
Freezing and Thawing . . . . Little to none	1.00
Moderate	1.05
Severe	1.15
Fog. . . . . Prevalent	1.10



(1) Use only one adjustment factor for these items.
(2) Use only one adjustment factor for this item, either freezing and thawing, or fog.

Utilizing the CGRA Highway Classification and Design Designation the recommended Warranting Values for guardrail installation are as indicated in Table F-3.

TABLE F-3

WARRANTING VALUES FOR GUARDRAIL INSTALLATION

Highway Classification	Warranting Value
UAD 50 , 60	50
UFD 50 , 60 , 65 , 70	50
UAU & UAD 30 , 40	70

The following procedure indicates a method for determining whether or not guardrail is required:

(1) Check the condition at the toe of the slope by entering Table F-2 (Roadside Conditions). If either a wall or water exists at the toe, a new "equivalent" height of slope is calculated as shown in Table F-2.

(2) Enter Table F-1 with the "equivalent" '**h**' value and determine the Basic Need Index Value for the appropriate side slope condition.

(3) Compare the adjusted need index with the appropriate warranting value from Table F-3. Guardrail is required if the adjusted need index is greater than the warranting value; if less, no installation is required.

Example

Determine whether or not guardrail is required on a fill section of UAD-60 having the following characteristics:

(1) Shoulder width = 15 feet
(2) Inside curvature (D) = 3 degrees
(3) Downgrade = 3 percent
(4) Height of fill = 6 feet on 3:1 slope to toe wall 3 feet high (18 feet beyond the overall shoulder).
(5) Climatic conditions = favourable.

Solution:

(1) As a toe wall is present, an "equivalent" '**h**' value is calculated from Table F-2.
5 x 3 feet (wall) + 6 feet (height of fill) = 21 feet

(2) From Table F-1, the Basic Need Index Value is 56 (**h** = 21 feet, side slope = 3:1).

(3) Adjustment factors from Table F-2 are ascertained and applied as follows:

Shoulder width	..... 1.0
Horizontal Curvature	..... 1.05
Profile Condition	..... 1.05
Roadside Condition	..... 1.0
Climatic Condition	..... 1.0
Combined Factor	..... 1.05 x 1.05 = 1.10
Adjusted Need Index	..... 56 x 1.10 = 62

As the adjusted Need Index value of 62 is larger than the warranting value (50) for a UAD-60, as listed in Table F-3, guardrail is required.

In order to simplify and shorten the procedure, the Nomograph shown in Figure F-1 may be used as an alternate to the procedure described above.

Nomograph Usage

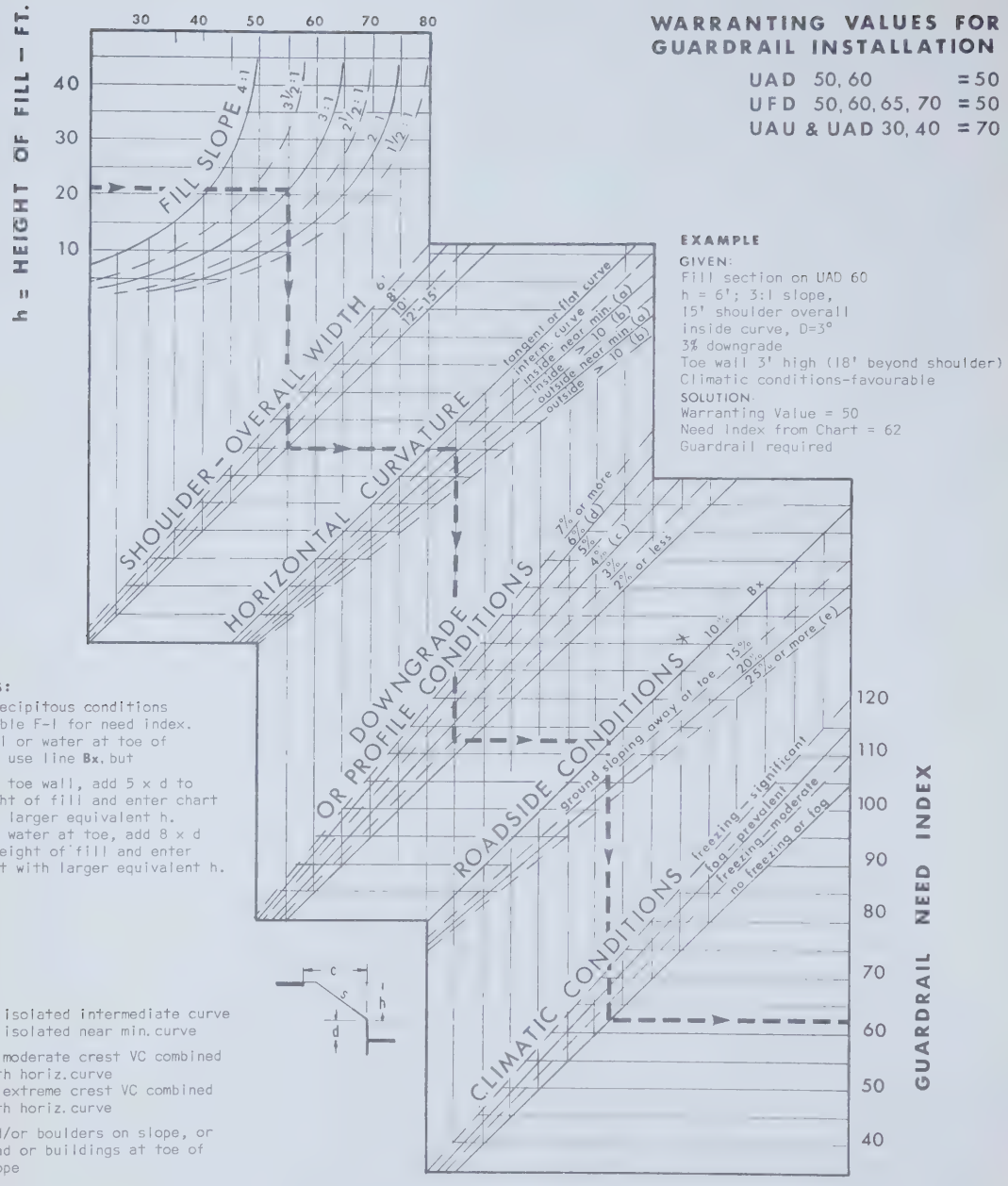
Enter the top left of nomograph with the height of fill (adjusted if so required) and proceed right to the appropriate curve designating the fill slope; at this point turn 90 degrees and project downward to the given shoulder width; proceed right to the next family of lines designating horizontal curvature, and repeat this process through the remaining variables. The adjusted guardrail need index is read on the right vertical scale. The nomograph may also be used in the reverse order by entering the lower right with the desired need index and reading the maximum height of fill permissable without guardrail on the upper left scale.

Guardrail Determination For Median Conditions

Divided highways may be grouped into two general categories, as follows:

(a) those having a median of narrow width (40 feet or less), and with their travelled ways at approximately the same elevation,

(b) those having a wide median, and with their travelled ways being independent of each other with respect to both alignment and profile.



WARRANTING VALUES FOR GUARDRAIL INSTALLATION

UAD 50, 60	= 50
UFD 50, 60, 65, 70	= 50
UAU & UAD 30, 40	= 70

EXAMPLE

GIVEN:
Fill section on UAD 60
h = 6'; 3:1 slope,
15' shoulder overall
inside curve, D=3°
3% downgrade
Toe wall 3' high (18' beyond shoulder)
Climatic conditions-favourable

SOLUTION:
Warranting Value = 50
Need Index from Chart = 62
Guardrail required

NOTES:

*For precipitous conditions see Table F-1 for need index. If wall or water at toe of slope, use line **Bx**, but

- with toe wall, add 5 x d to height of fill and enter chart with larger equivalent h.
- with water at toe, add 8 x d to height of fill and enter chart with larger equivalent h.

(a) or isolated intermediate curve
(b) or isolated near min. curve
(c) or moderate crest VC combined with horiz. curve
(d) or extreme crest VC combined with horiz. curve
(e) and/or boulders on slope, or road or buildings at toe of slope

GUARDRAIL NEED INDEX CHART

FIGURE F-1

In case (a), the primary hazard is considered to be the head-on or across the median type of collision. In case (b), due to the characteristics of the wide median, the situation is similar to that of an embankment or roadside obstacle condition, and should be treated accordingly.

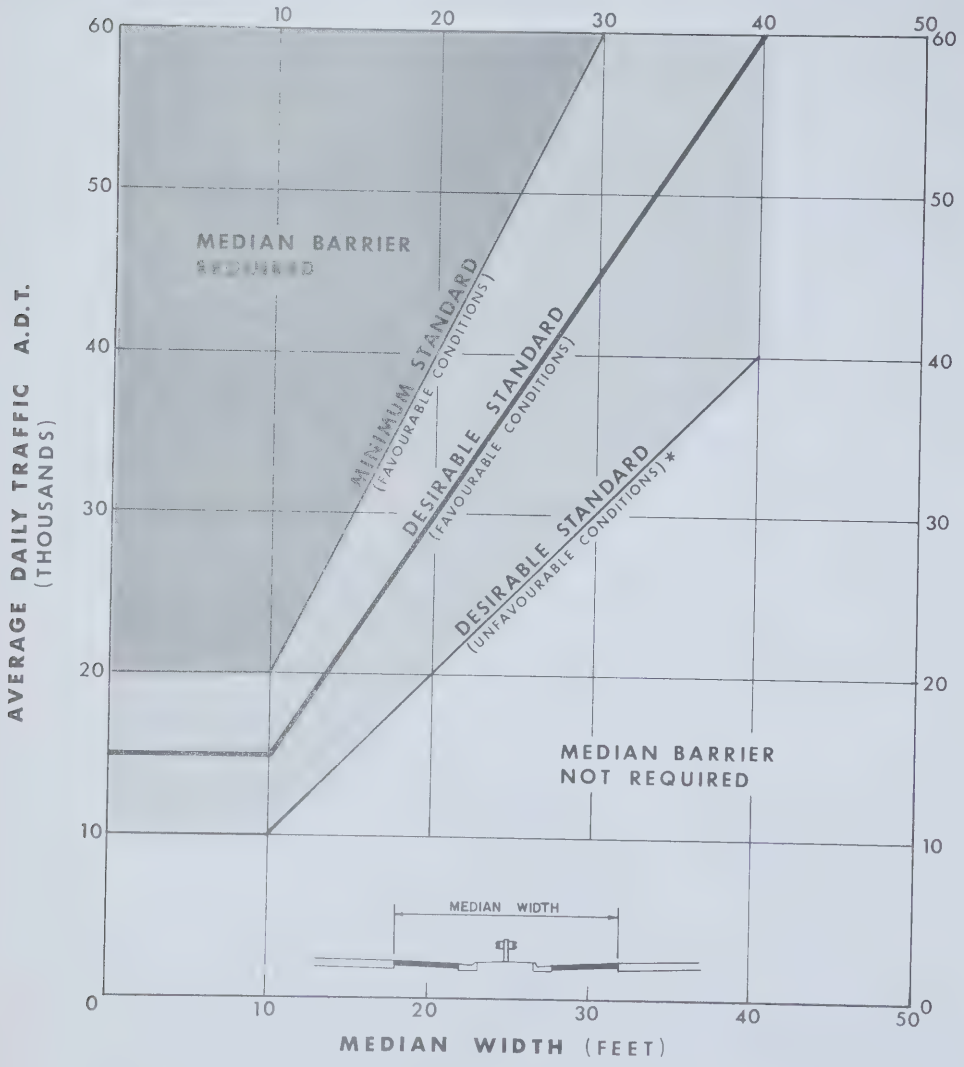
Median barriers are normally omitted on medians of 40 feet or more in width, except (1) where directional lanes are at different levels, (2) protection from obstacles within the median is required, or (3) on the basis of accident experience.

For category (a) (median width of 40 feet or less), an emperical method of assessing a warrant for guardrail (median barrier) is to relate the highway ADT (in thousands) in terms of the median width or distance between the edges of the opposing travelled ways.

Using such a relationship, and based on both favorable alignment and climatic conditions, a desirable standard suggested by the Highway Research Board - "Special Report 81" requires a median barrier installation when the ADT (in thousands) equals 1.5 times the width of the median in feet. Substituting twice the width in place of the 1.5 value is considered a minimum standard based upon experience of the California Division of Highways.

In difficult terrain and where icing frequently occurs, a third standard (Pennsylvania Turnpike) may be considered with the ADT (in thousands) equal to the width of the median.

These three standards are indicated on Figure F-2 and may be used as a guide for median barrier warrants.



MEDIAN BARRIER REQUIREMENTS

FIGURE F-2

Geometric Requirements

Types of Guardrail

Two types of guardrail are considered in detail in this Manual, the steel "W" section flex beam rail, and the New York box beam rail.

Post Spacing & Rail Height

A commonly used standard for post spacing and guardrail height calls for 12-foot - 6 inch centers with the top of rail mounted 27 inches above the ground surface measured from the base of post. Recent tests by other agencies have indicated, however, that such spacing is inadequate where large deflections cannot be tolerated; (e.g. narrow medians, highway obstacles).

It is, therefore, recommended in this Manual that in the vicinity of bridge abutments, sign structures, etc., the post spacing be reduced as detailed in Exhibits F-1 to F-4 inclusive.

Sections (A-A) and (B-B) on these exhibits illustrate both the rail offset dimension (**A**) measured from face of curb to face of rail and the mounting height dimension (**B**).

Generally speaking, when the face of rail is located 1-foot or less from the curb face, the curb height may be considered as part of the mounting height since the small rail offset distance available causes the vehicle overhang to make contact with the rail before the wheels are able to strike the curbing. In such a case, the top of rail may be erected a vertical distance (**B**) of 23 inches measured from the top of curb.

When the rail offset (**A**) is greater than 1-foot, a vehicle will tend to ride up over the curbing and hence a (**B**) dimension of 27 inches should be maintained above the top of curb.

Post Size

Post size and spacing are also indicated on Exhibits F-1 to F-4 for both box and flex beam. In the case of flex beam when post spacing is 6 feet - 3 inches, 8 inch by 8 inch wooden posts 5 feet - 4 inches in length are required. However, where the 4-foot spacing is utilized, the post size should be increased to 10 inches by 10 inches.

On box beam installations a 3I5.7 is recommended.

In order to minimize the pocketing of a vehicle, all flex beam guardrail should be blocked out or supported away from the post. An 8 inch by 8 inch by 14 inch wooden block is recommended for this purpose.

Installation Length

The minimum lengths deemed necessary in order to develop the proper operating characteristics of both types of guardrail are shown on the plan views of Exhibits F-1 and F-2. The overall lengths will, of course, be dependent upon the specific situation.

Short isolated sections of guardrail should be avoided wherever possible, as should short gaps in an otherwise continuous installation.

Typical End Sections

The introduction (approach) end of a guardrail installation is one of the most formidable highway obstacles with which traffic must contend. The standard terminal section with its rounded blunt end should no longer be utilized, as a head-on collision with such an obstacle generally causes a "spearing" of the vehicle, often resulting in serious injury to the occupants involved.

In order to alleviate this condition and based on tests by other agencies, both approach and terminal-end sections should be tapered downward and anchored into the ground as illustrated on Exhibits F-1 and F-2.

While it is recognized that vehicles encountering the sloped-end section at high speeds may, in effect, be "launched" or rolled off the guardrail, the sloped and anchored design is still recommended pending further research into this area.

The introduction or approach-end section should, in addition, be offset from the normal line of the remainder of the installation in order to minimize the possibility of a vehicle proceeding behind the guardrail and becoming involved with the hazard which it is intended to eliminate. An initial 4-foot offset, as shown on the exhibits, is recommended.

If the terminal-end section is not also sloped downward and anchored an additional 75 feet of guardrail is required beyond the warranted limits in order to assure full strength of the installation. While the added length offers no apparent saving in cost over the recommen-

ded anchored treatment, it does nevertheless increase the length of the potential hazard.

Anchorage to Structures

Structural abutments and bridge parapets often form potential obstacles to vehicles travelling in adjacent lanes, even when guardrail is installed for such protection. If the end of guardrail abutting the parapet is not anchored, a vehicle hitting the installation will be directed into the parapet-end as the rail will deflect upon impact.

In order to alleviate this condition and allow the vehicle to slide-on past the parapet-end, the guardrail should be extended, offset and fastened to the parapet itself. The post spacing and size adjacent to the structure must, in addition, be altered to produce an effective stiffness transition, as indicated on Exhibits F-3 and F-4.

When using flex beam, a steel offset block is required rather than a wooded one, as a wooden offset block will be crushed against the concrete. By keeping the guardrail offset from the parapet on the introduction-end, the blocked-out effect of the rail is maintained and vehicles will not encounter the end of the parapet. At the exit-end, the guardrail is embedded into the parapet to eliminate the possibility of a vehicle becoming snagged.

The anchorage to structures, shown on Exhibits F-3 and F-4, is based on recent tests carried out in California and reported in the HRB Research Report No. M & R 636392-5 "Dynamic Tests of Short Sections of Corrugated Metal Beam Guardrail".

Guardrail Placement on Arterial Streets

In order to maintain a uniform cross-section on freeways, the minimum rail offset distance (**A**), between face of curb to face of rail, has been established as 1-foot, except in the case of continuous median guardrail. Arterial streets, having no shoulders, require different treatment. A minimum side clearance of 5 feet between edge of pavement and face of guardrail or bridge parapet is desirable as indicated by the lower half of Exhibit F-5. Sections (F) and (H) represent the installation with sidewalks while for the "no sidewalk" condition, the guardrail and parapet are offset 3 feet from the face of curb, assuming a 2-foot gutter, as shown by Sections (E) & (G). By providing this 3-foot setback on the structure, a uniform section is maintained throughout the arterial street length.

The continous sidewalk alignment shown, in (F) and (H), is recommended for a major arterial street. Although this treatment is desirable, it may not always be possible to achieve, due to conditions such as right-of-way limitations, etc.

Median Clearances

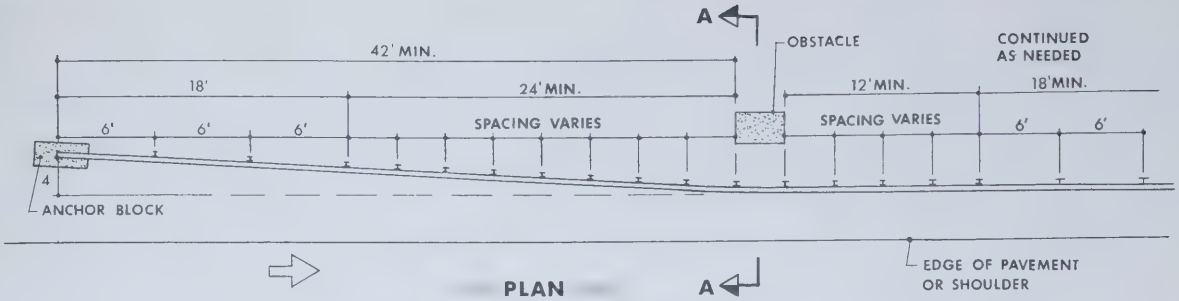
On narrow freeway medians containing obstacles such as structural piers, the lateral clearance distance (**C**), Section (A-A) of Exhibits F-1 and F-2, available is often very limited.

Minimum and desirable criteria for the placement of guardrail in conjunction with 2-foot and 4-foot median piers is shown on Sections (A) to (D) of Exhibit F-5. The "desirable" dimensions provide offset distances

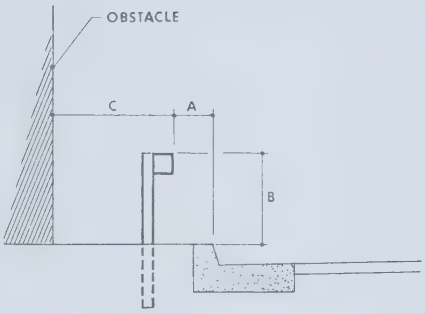
of 2 and 3 feet for box and flex beam respectively, from the curb face, while still allowing the guardrail space to "flex" before contact is made with the pier.

Basically, when a 2-foot pier is used in conjunction with a 30-foot median, desirable lateral clearances (**C**) of 3 feet (flex beam) and 4 feet (box beam) are obtainable. Using 6-foot shoulders, 2-foot gutters and box beam, the raised 14-foot portion, therefore, is comprised of the recommended rail offset (**A**) of 2 feet, **C** equal to 4 feet and a 2-foot pier; with flex beam both the **A** and **C** dimensions equal 3 feet. If this desirable situation cannot be attained the **A** dimension may be reduced, to 1-foot (box beam) or 2 feet (flex beam), resulting in a minimum median width of 28 feet.

In order to maintain the recommended **A** and **C** dimensions with a 4-foot pier, the median width should be increased to 32 feet. When this is not feasible the **A** distance may be reduced, the same amount as for the 2-foot pier, resulting in a median width of 30 feet which is the minimum acceptable for this condition.



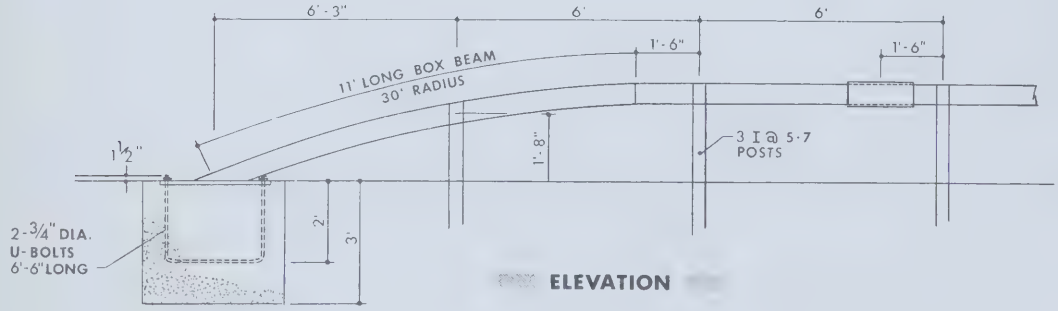
PLAN



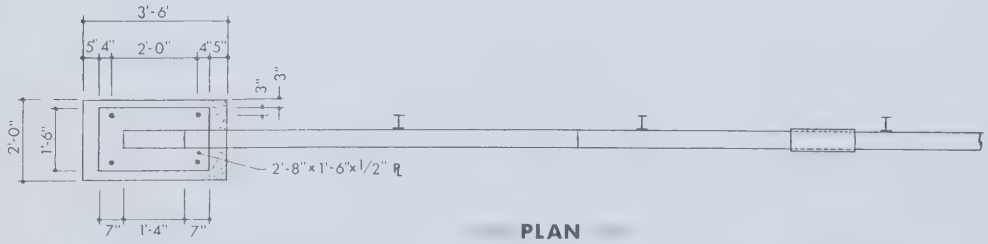
SECTION A-A

NOTES

1. WHEN A = 1·0', B = 23"
   A > 1·0', B = 27"
2. WHEN C ≥ 4·5', POST SPACING IS 6·0'
   C < 4·5', POST SPACING IS 4·0'
3. WHEREVER GUARDRAIL IS INTRODUCED INITIAL SECTION IS OFFSET 4' AS SHOWN ABOVE. MINIMUM LENGTH OF TAPER 42'.
4. BOTH GUARDRAIL INTRODUCTION AND TERMINAL-END TREATMENT TO CONSIST OF SLOPING RAIL DOWNWARD AND FASTENING TO ANCHOR BLOCK AS INDICATED BELOW.



ELEVATION

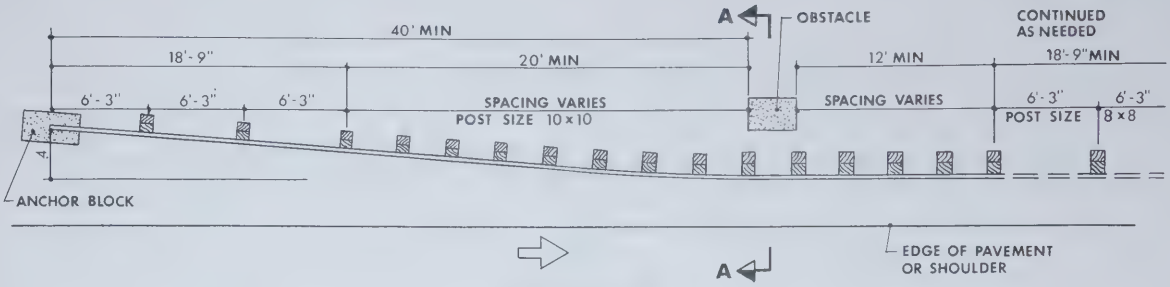


PLAN

INTRODUCTION & TERMINAL-END TREATMENT

PROVINCE OF ALBERTA
URBAN HIGHWAY DESIGN GUIDE

BOX BEAM GUARDRAIL REQUIREMENTS



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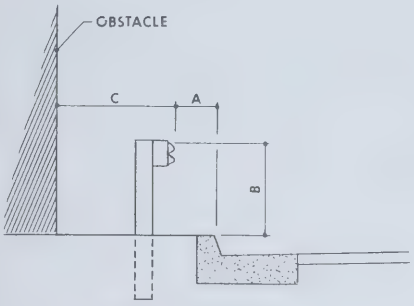
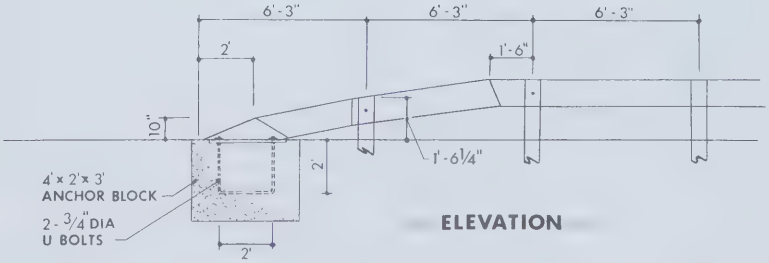


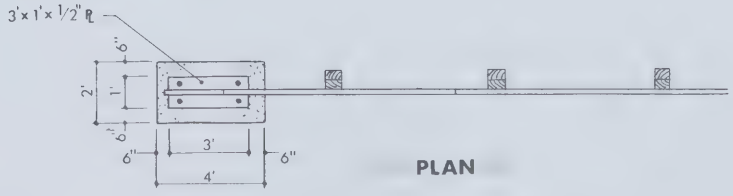
SECTION A-A

NOTES

1. WHEN A ≤ 1·0', B = 23"
   A > 1·0', B = 27"
2. WHEN C ≥ 3·0', POST SPACING IS 6'-3"
   C ≤ 3·0', POST SPACING IS 4·0'
3. WHEREVER GUARDRAIL IS INTRODUCED INITIAL SECTION IS OFFSET 4' AS SHOWN ABOVE. MINIMUM LENGTH OF TAPER 40'.
4. BOTH GUARDRAIL INTRODUCTION AND TERMINAL END TREATMENT TO CONSIST OF SLOPING RAIL DOWNWARD AND FAST ENING TO ANCHOR BLOCK AS INDICATED BELOW.



ELEVATION

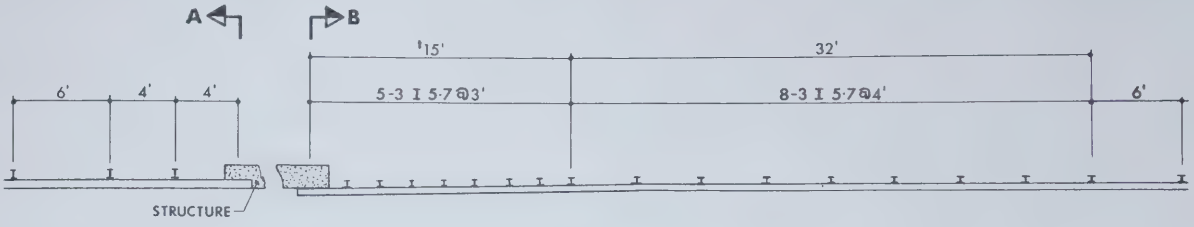


PLAN

INTRODUCTION & TERMINAL-END TREATMENT

PROVINCE OF ALBERTA
URBAN HIGHWAY DESIGN GUIDE

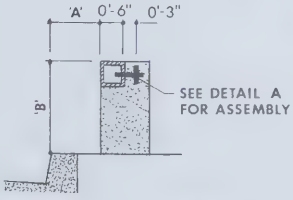
FLEX BEAM GUARDRAIL REQUIREMENTS



PLAN

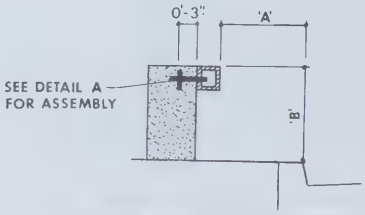
'4' SPACING MAY BE USED FOR DESIGN SPEEDS UNDER 50M.P.H.

ELEVATION

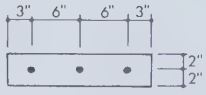


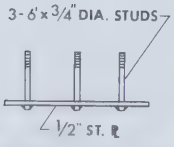
SECTION A-A

NOTE
FOR DIMENSIONS 'A' & 'B'
SEE EXHIBIT F-2



SECTION B-B

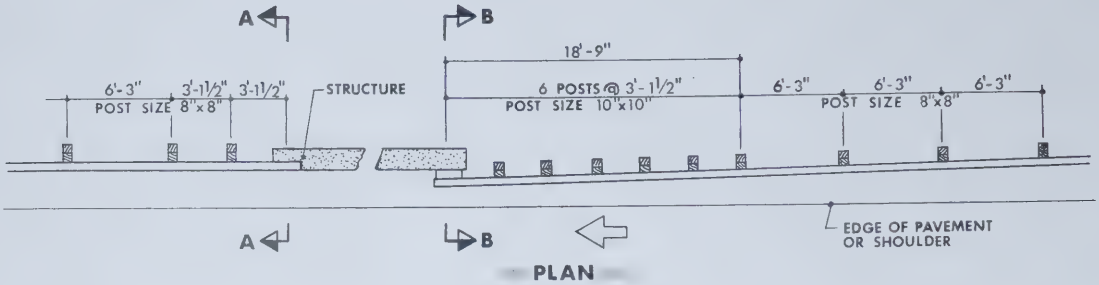




DETAIL A
ANCORAGE ASSEMBLY

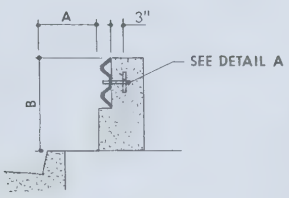
PROVINCE OF ALBERTA
URBAN HIGHWAY DESIGN GUIDE

BOX BEAM GUARDRAIL
ANCHORAGE TO STRUCTURE



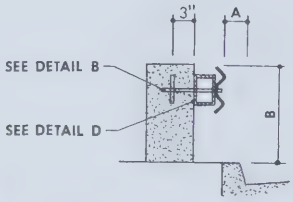
PLAN

ELEVATION

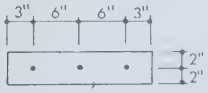


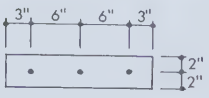
SECTION A-A

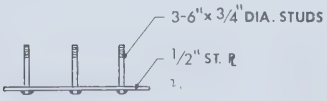
NOTE
FOR DIMENSIONS A & B
SEE EXHIBIT F-2



SECTION B-B

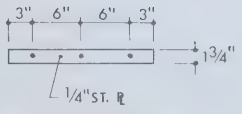




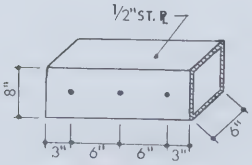


DETAIL 'A'
ANCHORAGE ASSEMBLY

DETAIL 'B'
ANCHORAGE ASSEMBLY



DETAIL 'C'
PLATE WASHER

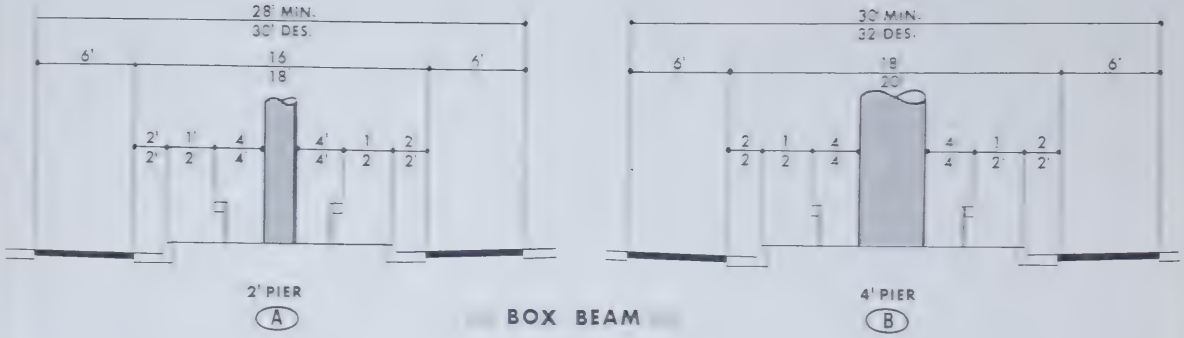


DETAIL 'D'
METAL BOX SPACER

NOTE
WHEN METAL BOX SPACER IS INSTALLED PLACE 1"x5" PIPE SPACERS ON ¾" BOLTS PASSING THROUGH INTERIOR OF BOX.

PROVINCE OF ALBERTA
URBAN HIGHWAY DESIGN GUIDE

FLEX BEAM GUARDRAIL
ANCHORAGE TO STRUCTURE



2' PIER
(A)

BOX BEAM

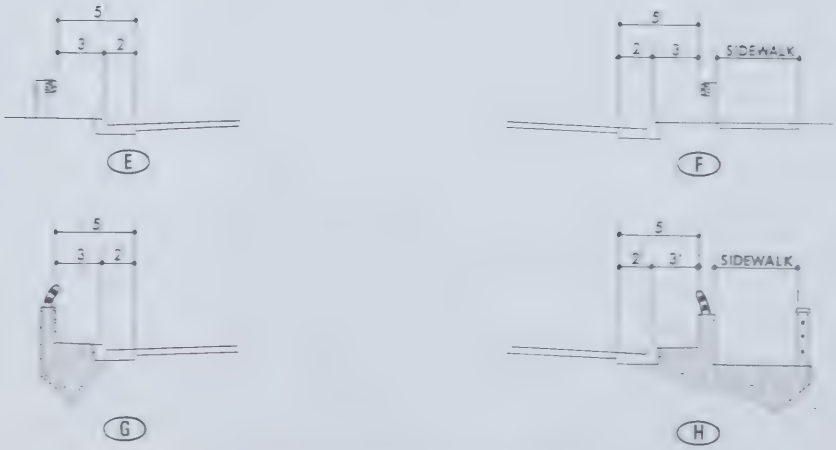
4' PIER
(B)

2 PIER
(C)

FLEX BEAM

4' PIER
(D)

MEDIAN TREATMENT AT PIERS ON FREEWAYS



(E)

(F)

(G)

(H)

GUARDRAIL PLACEMENT ON ARTERIAL STREETS

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URBAN HIGHWAY DESIGN GUIDE

GUARDRAIL CLEARANCES

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CHAPTER · G

EXIT TERMINALS

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CHAPTER · G

EXIT TERMINALS

The intent of this Chapter is to provide guide lines which will enable the designer to easily and quickly prepare layouts for exit terminals compatible with the different classifications of highways involved. In general, the design criteria is of a higher standard than that contained in AASHO "Blue Book" 1965. It is the Committee's opinion, however, that the higher standards suggested in this Chapter are warranted in view of the continuing demands for better, safer highways needed to cope with current traffic speeds and volumes.

The specifications provided will also allow standardization of design - an aspect which has been noticably lacking throughout Western, if not all, of Canada. Logically, a motorist is entitled to expect uniform operating conditions in critical areas such as exit and entrance terminals, particularly on high speed, high volume facilities.

The suggested designs contained herein are based on the following "philosophies":

(1) Vehicles must be able to exit from the mainline in such a manner that no reduction in speed, or other form of interference, is imposed on the mainline traffic.

(2) Vehicles leaving the mainline must be able to travel on a "natural" path, without encountering any irregularities which might cause erratic operation of the vehicle.

(3) Distances adequate for comfortable deceleration to the controlling curve speed must be provided.

The Chapter has been broken into three main parts, as follows:

(1) Speed Change Lane Criteria - (the portion of the exit ramp upstream from the approach nose) including alternate gore treatments.

(2) Transition Curve Criteria - (the portion of the exit ramp between the approach nose and the controlling curve of the ramp) dealing with the length and location of the spiral.

(3) Typical Exit Terminals - involving specific recommendations for each classification of highway.

Speed Change Lane Criteria

Alignment

It is considered that a tapered or curvilinear design, allowing vehicles to leave the through lane without a reduction in speed, best fulfills the foregoing requirements. The right edge of the ramp pavement is used as the control line for the alignment design illustrated in Exhibit G-1. The exit, or speed change lane design consists of two compound curves, D_1 and D_2. In order to develop a "take-off" from the outer edge of mainline pavement a short length (200 feet) of 1-degree curve (D_1) is used. Curve (D_2) is then introduced to provide the desired tapered design and varies from 6 minutes at 80 mph to 1-degree for 40 mph. A spiral (Ls) is employed to transition D_2 to the controlling degree of curvature on the ramp. The junction of D_2 and the

spiral (Ls) is usually located at or near the approach nose of the ramp. The location and length of the spiral is covered in detail under the section - "Transition Curve Criteria".

The taper distance (**B**) is the distance measured from where the ramp is 6 feet wide to the wedge point (beginning of wedge). The **B** distance is an arbitrary value, and is varied as necessary to produce the desired curvilinear design relative to varying design speeds.

The 6-foot dimension is used to start the **B** distance, as it represents half a lane width, and is in accordance with the AASHO suggestion of measuring the length of a tapered deceleration lane from the location where the added pavement is 6 feet wide.

The exit ramp is widened or flared by 2 feet at the wedge point in order to give the motorist a little more flexibility of driving path when entering this portion of the speed change lane (see Exhibit G-1).

This exhibit also illustrates the recommended offsets for the wedge point and approach nose, measured from the outer edge of the mainline and the inner curvature of the ramp pavement, and lists in tabular form the values of **B**, $\mathbf{D}_1$ and $\mathbf{D}_2$ considered to be appropriate for the various highway classifications and ramp design speeds.

In order to assist the designer in selecting a design for any given combination of mainline and ramp design speeds, Tables G-1 to G-4 were developed, and list calculated dimensions for each of the components making up the geometry of the speed change lane alignment.

Figure G-1 illustrates the dimensions listed in Tables G-1 to G-4.

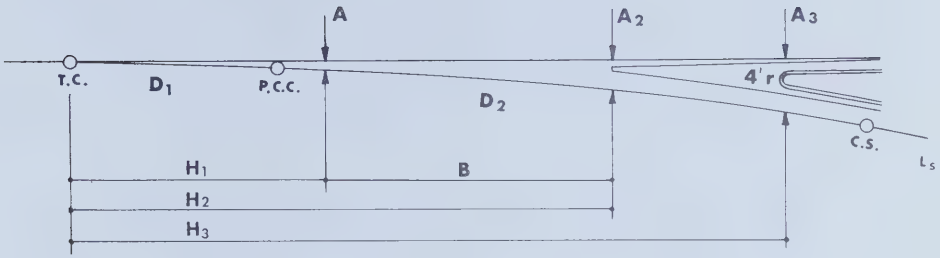


FIGURE G-1

TABLE G-1

1-LANE UAD TANGENT TO UAD

(Ramp width 17' - Exhibit G-3)

Given

A_1	A_2	A_3	D_1	D_2	H_1	H_2	H_3	B
6'	27'	38'	1°00'	1°00'	262'	556'	660'	294'
			1-00	0-45	264	589	707	325
			1-00	0-30	266	636	775	370
			1-00	0-24	267	661	813	394
			1-00	0-12	269	732	926	463

TABLE G-2

2-LANE UAD TANGENT TO UAD OR UFD

(Ramp width 24' - Exhibit G-3 & G-4)

Given

A_1	A_2	A_3	D_1	D_2	H_1	H_2	H_3	B
18'	37'	47'	1°00'	1°00'	262'	535'	633'	273'
			1-00	0-45	264	566	677	302
			1-00	0-30	266	608	739	342
			1-00	0-24	267	631	774	364
			1-00	0-12	269	694	875	425

TABLE G-3

1-LANE UFD TANGENT TO UFD

(Ramp width 14' - Exhibit G-5)

Given

A_1	A_2	A_3	D_1	D_2	H_1	H_2	H_3	B
6'	24'	37'	1°00'	1°00'	262'	524'	651'	262'
			1-00	0-45	264	553	697	289
			1-00	0-30	266	594	764	328
			1-00	0-24	267	615	800	348
			1-00	0-12	269	675	909	406
			1-00	0-06	271	720	1000	449

TABLE G-4

2-LANE UFD TANGENT TO UFD OR UAD

(Ramp 24' - Exhibit G-6)

Given

A_1	A_2	A_3	D_1	D_2	H_1	H_2	H_3	B
18'	37'	49'	1º00'	0º24'	267'	631'	800'	364'
			1-00	0-12	269	694	909	425
			1-00	0-06	271	743	1000	472

NOTES:

1. The above **H** distances were calculated using the Ices Cogo computer system Modification #1.
2. $B = H_2 - H_1$.
3. Computations are based on the assumptions that the C.S. lies at or beyond the approach nose. When the C.S. comes in advance of the approach nose, adjustments to the H_2, H_3 and **B** distances will be required.

Exit Terminal Treatment

Exhibit G-1 illustrates two methods of exit terminal treatment. In each case, the wedge area is constructed of contrasting pavement, and is of identical geometric layout. The only difference is in the painting technique, as shown on Exhibit G-1 "Alternate Exit Terminal Treatment". The wedge area may also be "chevroned" if desired.

Figures G-2 and G-3 indicate the pavement areas available to the driver, for mainline travel and ramp exiting, for each method of exit terminal treatment.

Each design has certain advantages and disadvantages from an operational point of view. However, both methods are considered to be acceptable, and may be applied at the option of the designer.

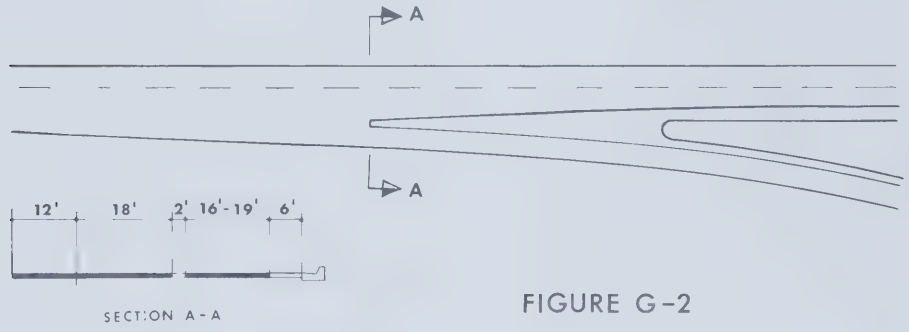


FIGURE G-2

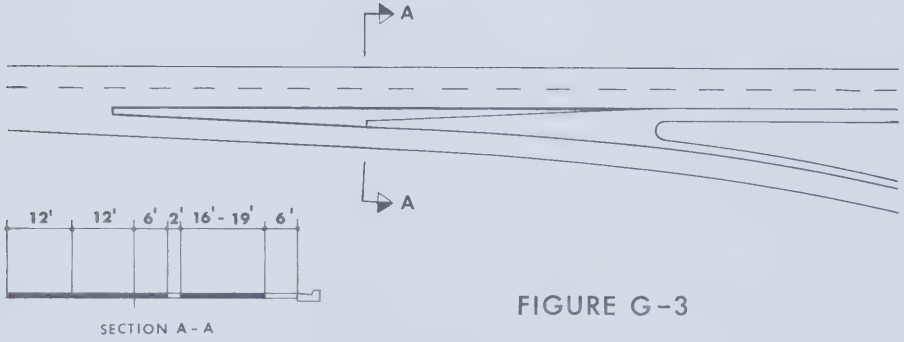


FIGURE G-3

Care should be taken to avoid confusion relative to the **B** distance if the alternate (Figure G-3) design is used.

Inasmuch as the wedge geometry is the same for both methods, the **B** distance remains the same for either.

Figure G-4 illustrates the relationship of **B** to the wedge points. As can be seen in this figure, the extension of the paint lines produces a second **B** distance (B_1) but this dimension is not used in any way in considering the geometric layout.

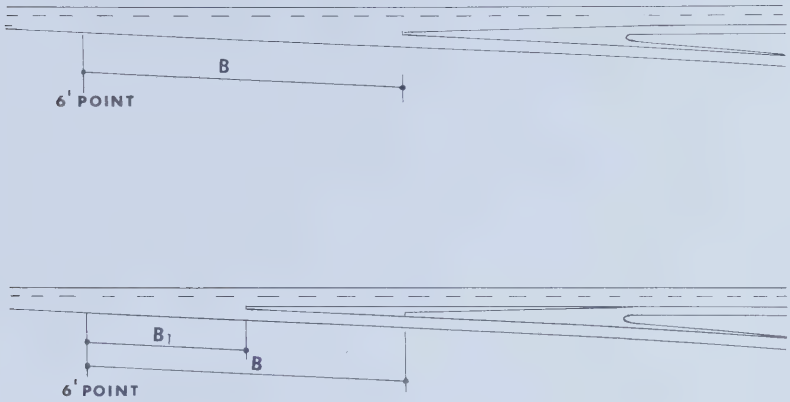


FIGURE G-4

Transition Curve Criteria

Deceleration

It is considered that the best and safest operation results when vehicles are encouraged to exit without any deceleration on the mainline. If vehicles do decelerate in the through lanes before exiting, they can cause braking, lane changing and other erratic manoeuvres to occur on the mainline itself. Therefore, if the premise of no deceleration on the through lanes is accepted, the following factors must be considered:

(1) The points at which vehicles start to decelerate, after they are clear of the mainline.

(2) How vehicles decelerate, and at what speed they are travelling when deceleration begins clear of the mainline.

Figures G-5, G-6 and G-7 illustrate 3 different ways that a vehicle may operate. In all cases it is assumed that when braking is involved, the vehicle decelerates in accordance with "comfortable" braking rates indicated in Figure V11-15B of AASHO.

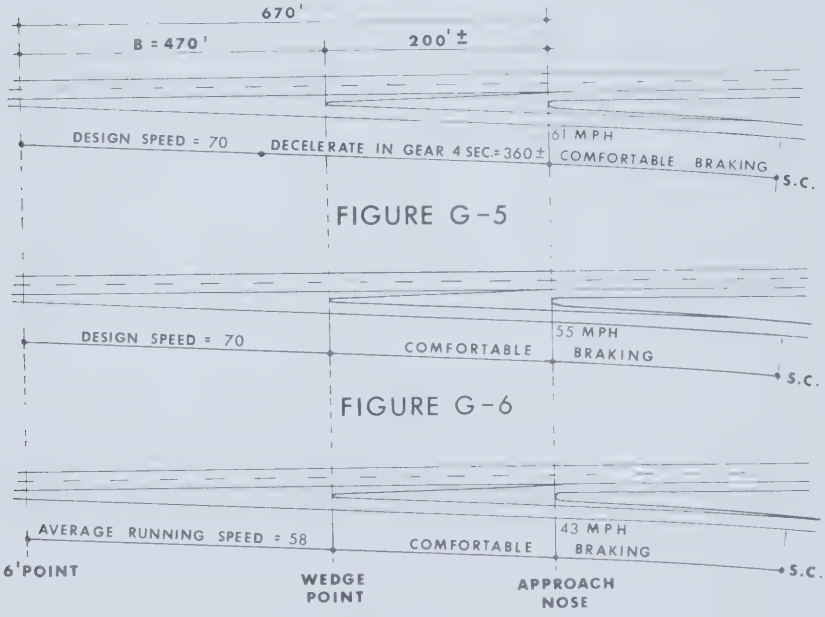


FIGURE G-5

FIGURE G-6

FIGURE G-7

Case 1

The vehicle leaves the roadway, Figure G-5, at a running speed of 70 mph, which is equivalent to the design speed. Approximately 360 feet before the approach nose, the vehicle starts to decelerate in gear for 4 seconds. This results in a speed of 61 mph at the approach nose, which is a 12.5 per cent speed reduction from

the mainline design speed.

Case 2

The exit speed of the car is 70 mph, Figure G-6, with no allowance for deceleration in gear. The comfortable braking starts at the wedge point and this results in a speed at the approach nose of 55 mph or a 21.5 percent reduction from the mainline design speed.

Case 3

The exit speed of 58 mph, Figure G-7, is based on the average running speed relative to a design speed of 70 mph as per AASHO. No allowance is made for deceleration in gear, and braking commences at the wedge point. This results in a speed at the approach nose of 43 mph, which is equivalent to a reduction of 38.5 percent from the mainline design speed.

As every driver operates his vehicle in a slightly different manner, it is difficult to say which, if any, of the situations outlined above apply to a general case. It is however, important to arrive at a design speed which will produce a safe situation for all drivers. In order to give the designer a range of values, 2 design speeds at the approach nose have been used in developing the recommended design criteria for transition curves:

(1) A 12.5 percent reduction of the mainline design speed (Figure G-5)

(2) A 35 percent reduction of the mainline design speed (approximately equivalent to Figure G-7)

The range in design speed at the approach nose provided by the 12.5 percent and 35 percent reductions give the designer a reasonable scope in deciding how high a standard he wishes to provide in any given situation. In general, the 35 percent reduction will give satisfactory results under most urban conditions.

Braking Distance

Even though the vehicle has undergone some deceleration after leaving the mainline, a braking distance (**C**) beyond the approach nose is still required in order to allow the vehicle to decelerate from its running speed, at the approach nose, to the ramp control speed.

Figure G-8 illustrates these (**C**) distances. The approach nose has been used as the control point, as it is always visible and marked so that the majority of drivers recognize it as the beginning of the ramp and gauge their speed by its location.

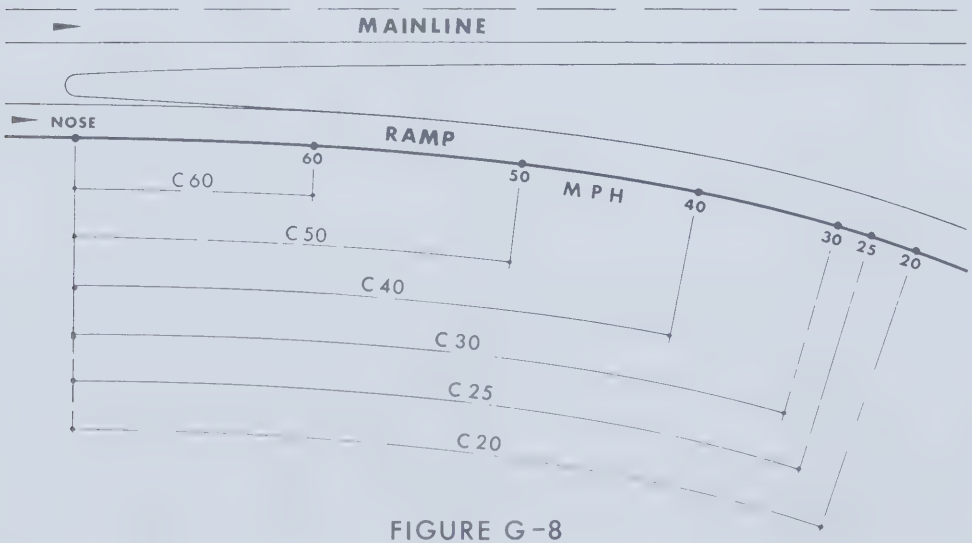


FIGURE G-8

The comfortable braking distances for various speeds relative to the 12.5 percent and 35 percent speed reduction are listed in Table G-5 (based on Figure V11-15B AASHO).

TABLE G-5

COMFORTABLE BRAKING DISTANCE							
CONTROL POINTS		C 60	C 50	C 40	C 30	C 25	C 20
MAINLINE DESIGN SPEED	DESIGN SPEED AT NOSE WITH SPEED REDUCTION OF 12·5%* / 35·0%+	COMFORTABLE BRAKING DISTANCE					
80	70 / 52	150	280 / 30	390 / 160	480 / 270		
70	61 / 46		150	260 / 60	360 / 160	390 / 230	
60	53 / 39			160	260 / 110	300 / 160	
50	44 / 32			60	150	200 / 60	230 / 110
40	35 / 30ε				60	110 / 50	140 / 100

* Speed at approach nose assuming driver is travelling 12.5 percent slower than the mainline design speed.
\+ Speed at approach nose assuming driver is travelling 35.0 percent slower than the mainline design speed.
ε 30 mph assumed minimum design speed at approach nose.

It should be noted that when the **B** (taper) and **C** (braking) distances are combined along with the wedge, the resulting deceleration distance is greater than that provided in AASHO, Table V11-10.

The **C** distance of Table G-5 when multiplied by the ratio as shown in Table VII-11 (AASHO) gives the braking distance required on grades in excess of $\pm$ 2%.

Example

Given: Mainline design speed = 70 mph
Controlling ramp speed = 30 mph

	AASHO Criteria	UHDG Speed Reductions	
		12.5%	35%
Taper (**B**)	300'	470'	410'
Wedge Length	----	200±	200±
Braking Distance (**C**)	525*	360	160
Total Deceleration Length	525'	1030'	770'

* Includes taper.

While the recommended deceleration lengths appear to be significantly longer, it should be noted that AASHO states the following: "In special cases, as on high type expressways, where high sustained speeds are apt to occur, speed-change lanes may be measured to where the widening is a full lane in width. This results in an overall length equal to that shown in Table VII-10 plus the length of taper". (P. 357). If this criteria is applied to the foregoing example, the following results are obtained:

	AASHO	12.5%	35%
Total Deceleration Length	825'	1030'	770'

Therefore it is evident that the standards suggested in this Manual for exit ramp designs provide a range approximately centered on those suggested by AASHO for high type facilities.

Speed Curvature Relationship on Spirals

Spirals are used to effect a transition, both in curvature and speed, from the approach nose to the controlling curve of the ramp. The location and length of the spiral must be carefully chosen, as it is possible to use a spiral that will give an adequate **C** distance for the controlling curve, but be too short or improperly located for intermediate points on the spiral. The design speed of any point on the spiral is dependent on the equivalent curvature at that point and the equivalent curvature varies proportionately as the distance increases from the beginning of the spiral. Figure G-9 illustrates this principle. The equivalent curvature at the midpoint of a 38 degree spiral is 19 degrees; i.e., 50 percent of the length

of the spiral. Similarly, one quarter of the equivalent curvature is reached in one quarter of the spiral length.

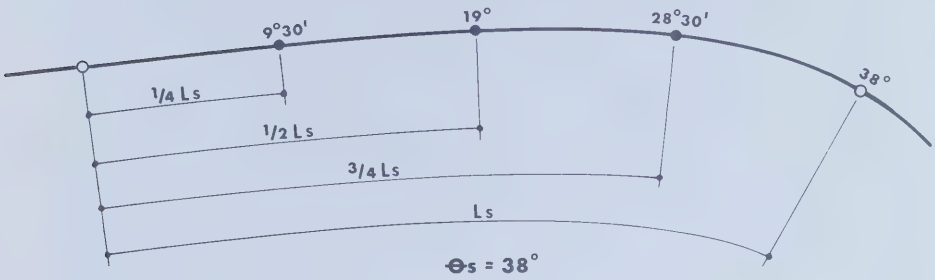


FIGURE G-9

In considering the speed-curve characteristics along the spiral, the following relationships can be developed:

5 degrees (60 mph) = 5/38 x Ls = 13% of the length of the spiral.

7 degrees (50 mph) = 7/38 x Ls = 18% of the length of the spiral.

12 degrees (40 mph) =12/38 x Ls = 32% of the length of the spiral.

24 degrees (30 mph) =24/38 x Ls = 63% of the length of the spiral.

38 degrees (25 mph) =38/38 x Ls = 100% of the length of the spiral.

Figures G-10 and G-11 illustrate the speed-curve-distance relationship for a 38 degree and 24 degree spiral respectively.

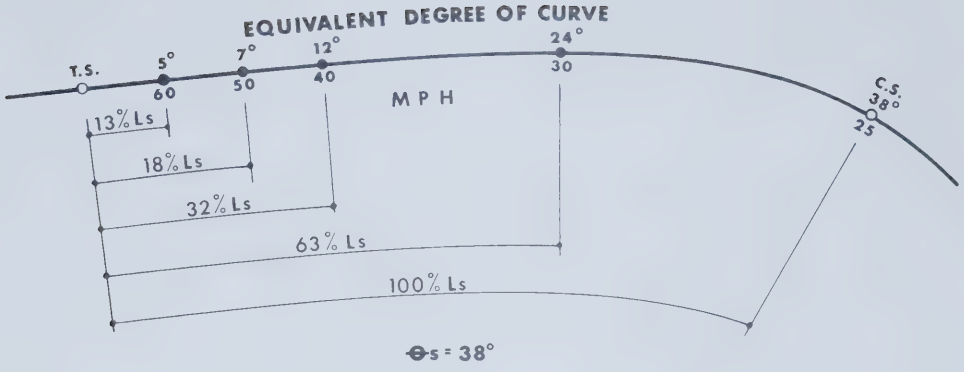


FIGURE G-10

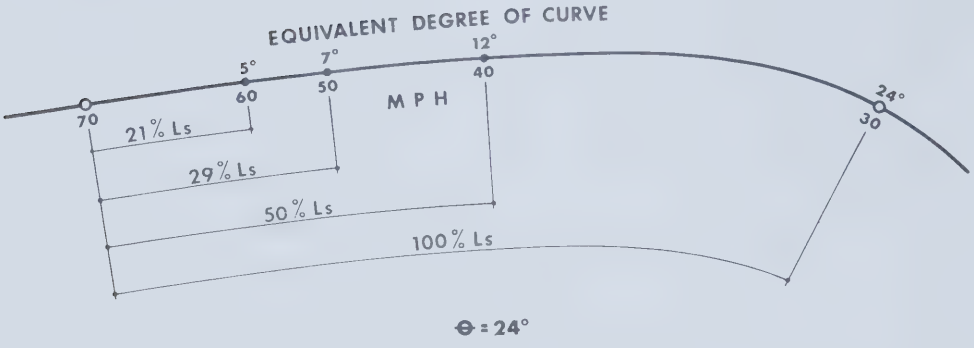


FIGURE G-11

It is apparent that the design speed does not change uniformly along the spiral as does the degree of curvature and it is this characteristic that makes it mandatory to check the intermediate points on the spiral to ascertain whether or not the required **C** or deceleration distances are met.

The relationship between deceleration and the speed-curve characteristics of a spiral is further illustrated by Figure G-12.

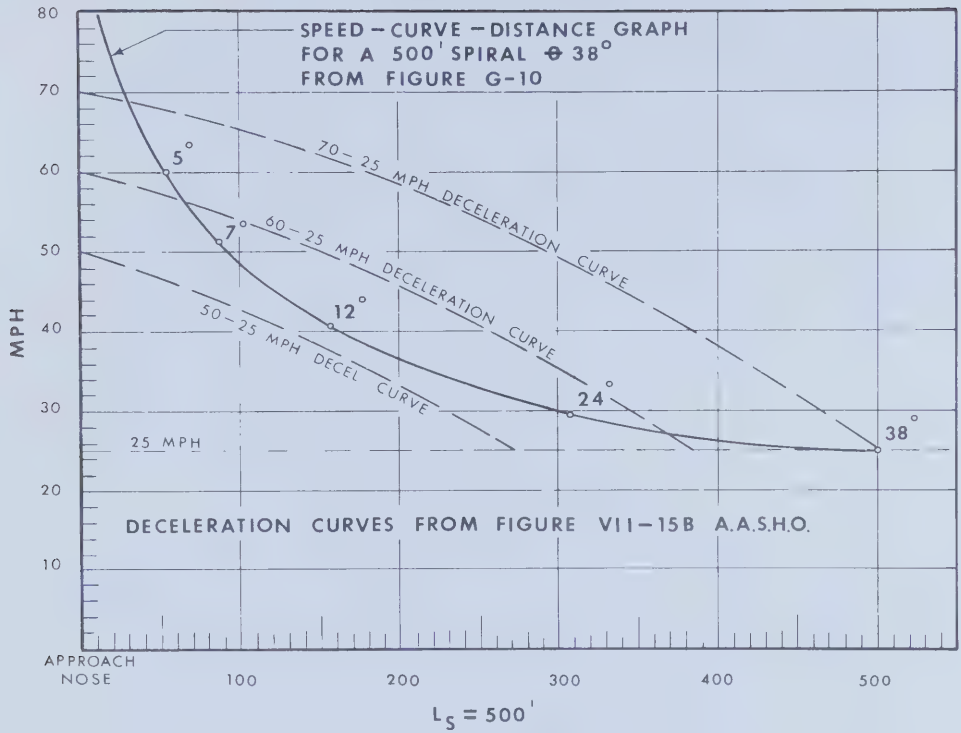


FIGURE G-12

The approximate braking distance required to decelerate from 70 mph to 25 mph is 500 feet. Figure G-12 shows the Speed-Curve-Distance Graph plotted for a 500-foot spiral.

Superimposed on this graph are deceleration curves (braking distances) for 70 to 25 mph, 60 to 25 mph, and 50 to 25 mph as derived from Figure VII-15B of AASHO.

While the 500-foot spiral length meets the overall distance requirements in decelerating from 70 mph to 25 mph, virtually the entire spiral length is significantly inadequate in meeting

the speed requirements of the deceleration curves. In fact, the 500-foot spiral can only accommodate a speed of 50 mph at the approach nose.

The problem may be solved by shifting the spiral beyond the approach nose a distance sufficient to satisfy the mid-spiral requirements. In other words, if the speed-curve-distance graph on Figure G-12 is shifted to the right until there is no intersection between it and the appropriate deceleration curves, all conditions are satisfied.

Figure G-13 and Table G-6 illustrate and list, respectively, the distances available from the T.S. to the intermediate speed controls. These distances are referred to as the "**X**" distances, and are shown for 3 common ramp design curvatures (Dc) = 38 degrees; (Dc) = 24 degrees and (Dc) = 12 degrees.

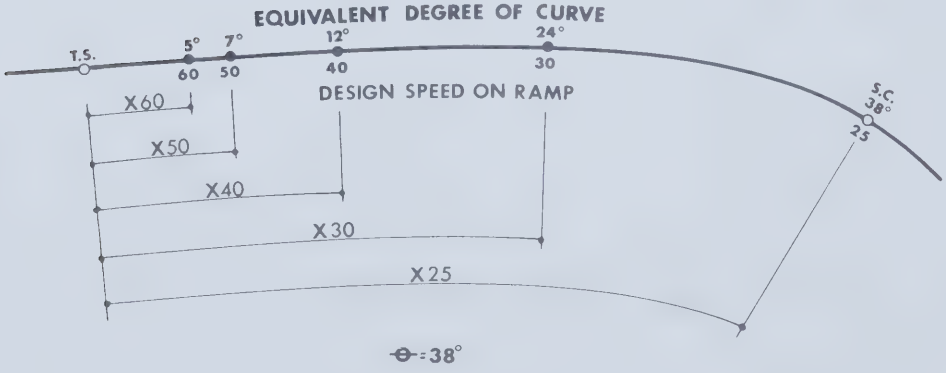


FIGURE G-13

TABLE G-6

SPEED-CURVE-DISTANCE RELATIONSHIPS

CONTROLLING RAMP CURVATURE		"X" DISTANCES (T.S. to Speed Control Points)					
		Ls	X60	X50	X40	X30	X25
Dc=38 25 mph		200	26	37	63	126	200
		300	40	56	95	189	300
		400	53	74	126	252	400
		500	66	92	158	315	500
		600	79	110	190	378	600
Dc=24 30 mph		200	42	58	100	200	
		300	62	88	150	300	
		400	83	117	200	400	
		500	104	146	250	500	
		600	125	175	300	600	
Dc=12 40 mph		200	83	117	200		
		300	125	175	300		
		400	166	234	400		
		500	208	292	500		
		600	250	350	600		

By comparing the **X** distances from Table G-6 with the **C** distances from Table G-5 for each intermediate point on the spiral, it is possible to determine the critical point, and hence the amount of "shift" that must be applied to correctly locate the spiral.

The shift of the spiral relative to the approach nose is designated as distance "**Y**" and is positive if located beyond the approach nose or negative if upstream from the approach nose. Figure G-14 illustrates the relationship between the approach nose, the **Y**, **X** and **C** distances.

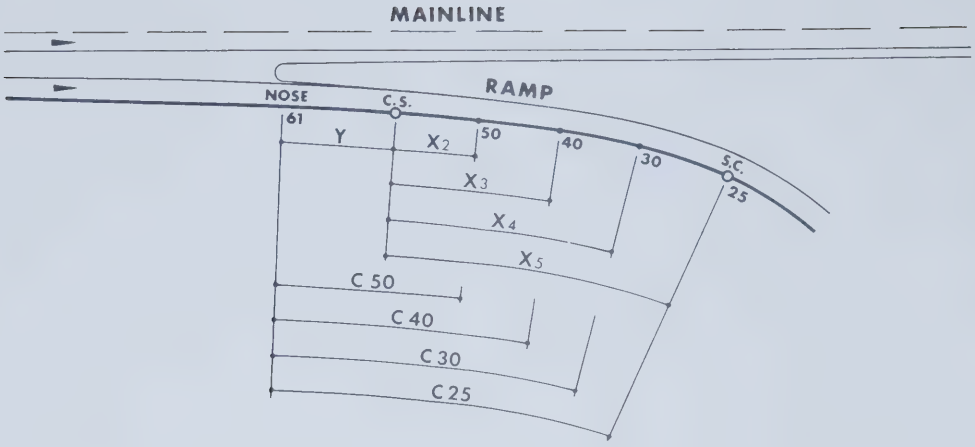


FIGURE G-14

It can be seen from this figure that the **C** distance, for any intermediate point, is made up of the **Y** distance plus the appropriate **X** distance.

The following example illustrates further the use of **C** and **X** distances in establishing the **Y** distance.

Example:

Given:
- Mainline Design Speed - 70 mph
- Ramp Design Speed - 25 mph
- Control Curve on Ramp - 38 degrees
- Speed Reduction - 12.5 percent
- **C** Values from Table G-5
- **X** Values from Table G-6

Ramp Design		Ls = 400		Ls = 500		Ls = 600	
Speed at Control Points	**C** Req'd.	**X** Avail.	**Y** Req'd.	**X** Avail.	**Y** Req'd.	**X** Avail.	**Y** Req'd
50 mph	150	74	+76	92	+58	110	+40
40 mph	260	126	+(134)	158	+(102)	190	+(70)
30 mph	360	252	+108	315	+45	378	----

Y = C - X

Considering the 400-foot spiral, the required **Y** distances for the various speed control points are as follows:

(50 mph) **Y** = 150 - 74 = 76
(40 mph) **Y** = 260 - 126 = (134) Controlling Value
(30 mph) **Y** = 360 - 252 = 108

By inspection, the 40 mph control point is the most critical of all three spirals compared, and the corresponding **Y** distance could be used as a basis for preliminary design. If space permits, the longer spiral, which allows the shortest **Y** distance, would be preferable, as the driver would be introduced to the spiral curvature at an earlier point, thus alerting him to adjust his speed. The longer **Y** distance may have a tendency to lull the driver into continuing his exiting speed until he feels the curvature of the spiral. This could cause him to over-drive the transition area. For this reason it is considered desirable that positive **Y** distance be held to a maximum of 100 feet.

Exhibit G-2 illustrates in tabular form the recommended location and length of Exit Terminal spirals relative to mainline and ramp design speeds. The **Y** values indicated represent the largest positive and/or smallest negative number rounded to the nearest 10. When exit terminals occur <u>at-grade</u> the **Y** values, according to the formula **Y** = **C**(required)-**X**(available) will be either positive or zero. While desirable, for reason of uniformity, in applying this same design criteria to exit terminals <u>on-structure</u> the resulting additional structure width may make cost the major consideration. By commencing the C.S. point in advance of the approach nose the amount of extra structural width required is reduced, hence the use of negative **Y** values. Due to the inherent problems associated with excessive roll-over and the speed-curvature relationship of the spiral, negative **Y** values should not exceed 100 feet.

In the event that the designer does not wish to use spirals longer than 400 feet (convenience in layout, etc.) the Table of Exhibit G-2 may be modified as follows:

Mainline Design Speed	Design Speed At Approach Nose 12.5% Reduction	Controlling Ramp Curvature			
		12-degrees		24-degrees	
		Ls	Y	Ls	Y
80 mph	70 mph	400	+60		
70 mph	61 mph			400	+60

It should be noted that a minimum spiral length of 200 feet is required to produce an effective transition.

Superelevation

For a more exact resolution of the **X**, **Y** values used in the previous discussion, the designer may wish to make adjustments to compensate for the effects of varying superelevation rates and side friction factors along the length of the spiral curve. (**X** distances, shown in Table G-6, were calculated assuming 0.08 superelevation was available to provide for the design speeds of the intermediate points on the spiral).

It should be clear, however, that the assumptions made in establishing the general "rationale" dealing with deceleration characteristics are such that small changes in the **X** distances due to superelevation differences are hardly significant.

Care must be taken to ensure that the superelevation is distributed over the spiral in such a manner that the resulting edge profiles

are aesthetically pleasing, and to ensure that the vehicle operator does not encounter a sudden change in driving characteristics on the ramp. The combination, or balance, of superelevation and side friction along the spiral should produce a "feed-back" or "roadway feel" such that the driver is encouraged to decelerate continuously throughout the transition curve till attaining the design speed of the controlling ramp curvature.

The upper portion of Figure G-15 illustrates what is considered to be a rational distribution of "**e**" and "**f**" over a 600-foot spiral (controlling speed of ramp 25 mph). The Values of "**f**" are established at close to maximum (from Figure B-1) in order that the driver will feel the need to decelerate as soon as he enters the spiral area. The "**e**" rate is distributed on a curvilinear basis in order to best suit the speed-curve characteristics of the spiral. Both "**e**" and "**f**" transition smoothly relative to each other and to the spiral.

The lower portion of Figure G-15 illustrates the speed distribution curve resulting from the allocation of "**e**" and "**f**" over the spiral, and is calculated by the formula $V^2 = (e+f) \times 85{,}900/D$ This speed distribution curve can be combined graphically with a plot of the **C** distance (Table G-5) to establish a more exact **Y** distance.

Figure G-16 illustrates this solution. The deceleration curve (**C** distances) is first plotted. The speed distribution curve, from Figure G-15, is then overlayed and moved into position from the right, until it just touches the **C** curve. The **Y** distance is then found by measuring the distance on the graph between the C.S. and the approach nose of the ramp. It should be noted that the **Y** distance determined by the graphical method will be greater, due to the effect of superelevation distribution, than that indicated by the table on page G.19.

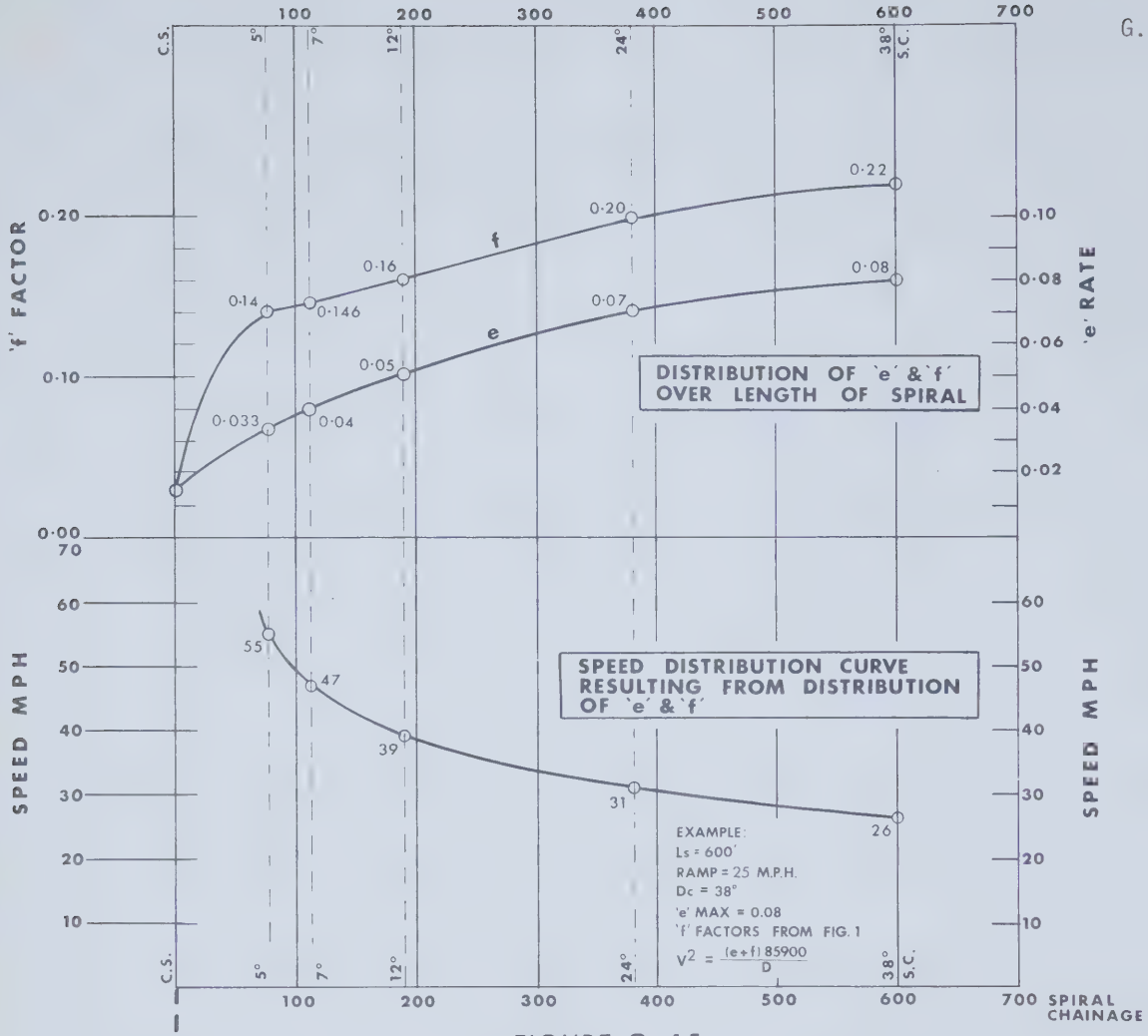


FIGURE G-15

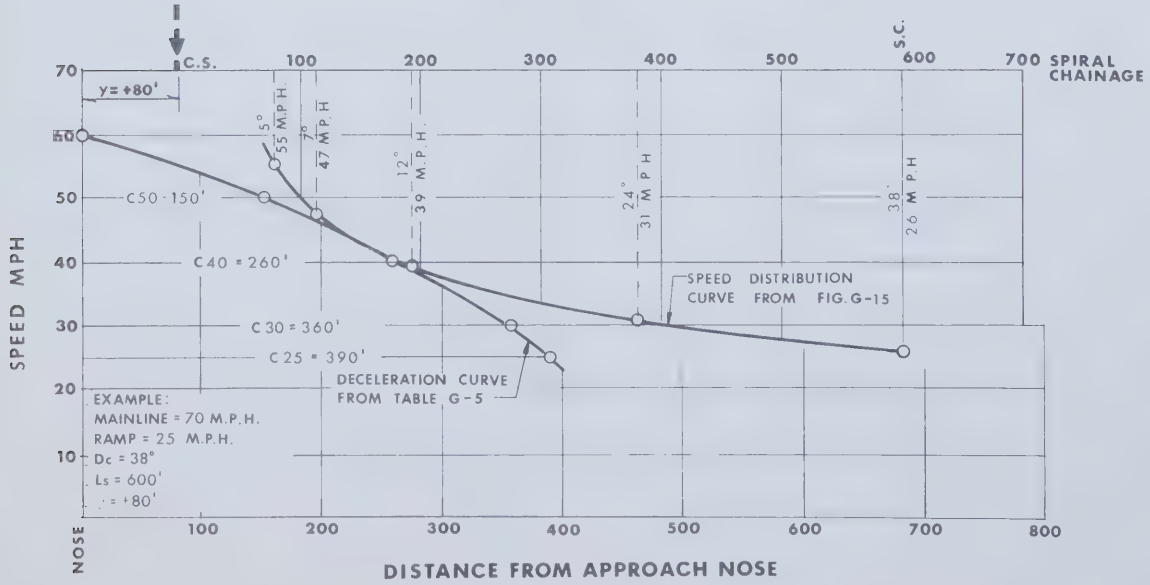


FIGURE G-16

In the event that conditions do not allow the use of the values in Exhibit G-3, it is suggested that the designer check the alternates available to him by means of the method illustrated in Figures G-15 and G-16.

Typical Exit Terminals

Typical Exit Terminal Design

Exhibits G-3 to G-7 have been prepared as guides to illustrate different types of exit terminals for UAD and UFD highways. As it is not possible to cover every situation, these examples will serve as a guide for other types that may be encountered. The information shown includes cross-sections at key points, offset dimensions and ramp widths.

As discussed in Chapter E, if a ramp either exits from, or enters onto a freeway, it should be of the UFD type. Therefore, it is possible to have a UAD highway exit terminal with either a UAD type ramp (no shoulders) or a UFD type ramp (with shoulders).

UAD Tangent - UAD

Exhibit G-3 illustrates a typical UAD exit. This exit is designed for traffic leaving a UAD street and continuing, via the ramp, to another UAD street. As UAD streets do not have shoulders, the ramp has no shoulders.

Typical sections at key points show the various pavement and offset dimensions; the tables provide the terminal geometrics and ramp widths.

The types of treatment are shown for the one-lane exit on Exhibit G-3. The standard tapered exit is shown at the top and a special case, where one-lane is dropped on a one-lane exit, is shown as an insert.

In the case of the "lane dropped" the clearance at section B-B should be increased from 10 feet to 12 feet adjacent to the through lanes, in order to provide extra clearance for vehicles which wish to return to the mainline.

UAD Tangent - UFD

Exhibit G-4 illustrates a typical exit from a UAD street to a freeway. As this is an exit to a freeway, a shoulder is provided on the ramp. The shoulder is started at the approach nose as shown on Figure G-17. The sections A-A, B-B and C-C illustrate how a minimum width of 19 feet is maintained to allow passing of a stalled vehicle. The 5-foot offset is gradually tapered to 2 feet in conjunction with the introduction of the shoulder. The starting point for the shoulder is placed at the approach nose, as drivers will tend to take short cuts and use the shoulder if it is introduced sooner.

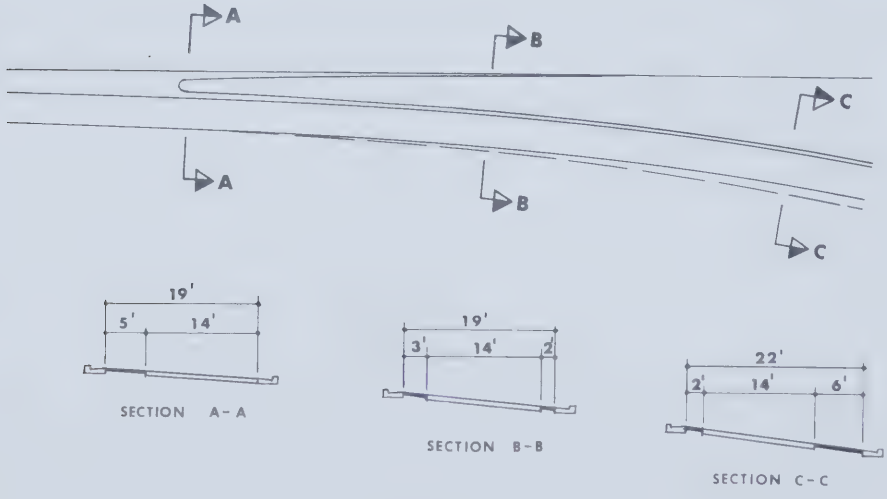


FIGURE G-17

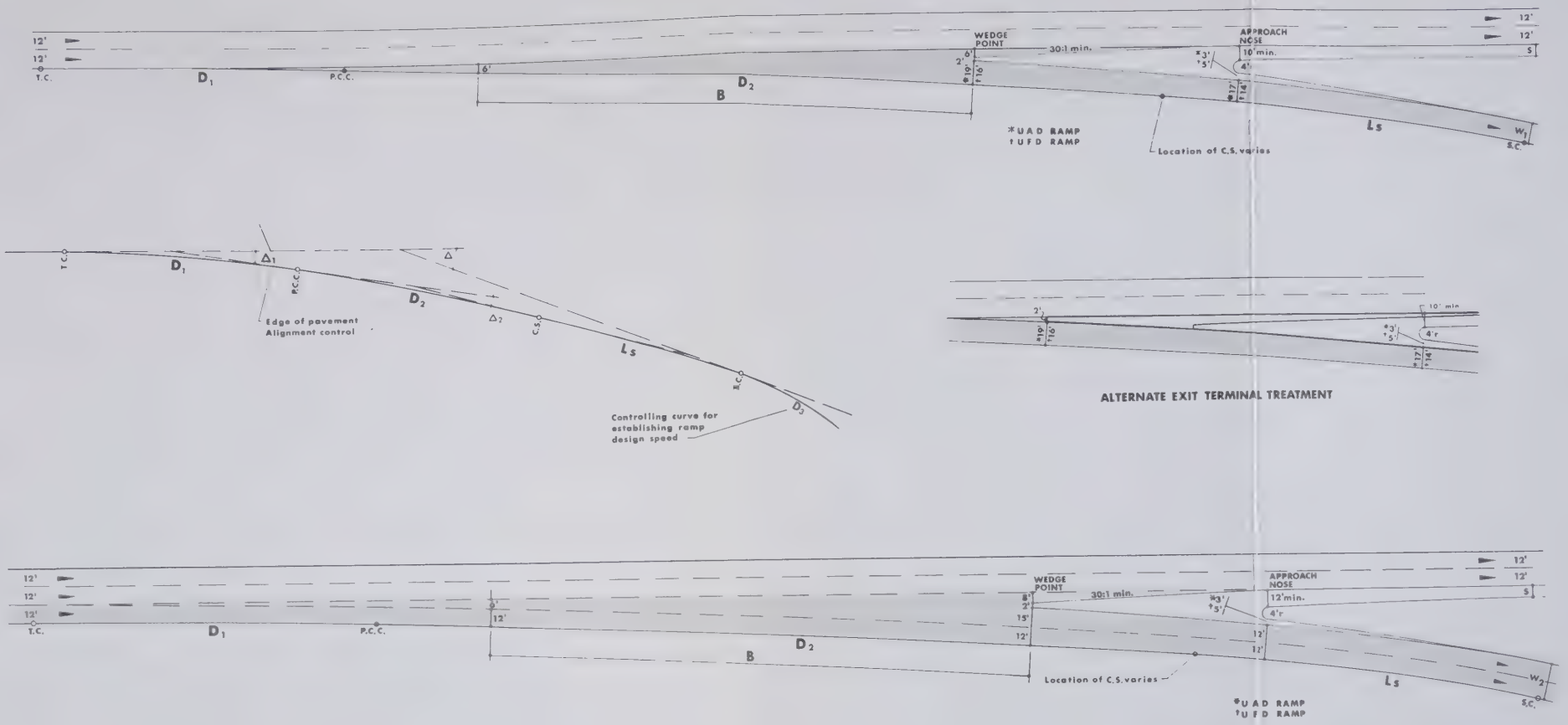
UFD Tangent - UFD/UAD

Exhibit G-5 illustrates a typical UFD exit to a UFD or UAD type highway and is self explanatory.

Curvilinear Exit Terminals

Typical curvilinear exit terminal designs are shown on Exhibits G-6 and G-7. Although the designs indicated are for specific UAD and UFD highways respectively, the basic method is interchangeable. In each case, no values are shown in the tables for D_1 and D_2 as the **B** distance controls. D_1 and D_2 are developed by compound curves and spirals to provide the appropriate **B** distance.

The exit terminal in Exhibit G-7 is the most difficult to produce, as it is necessary to develop a "wrap around" design. This is accomplished by curving the deceleration lane transition in the same direction as the curvature of the mainline until past the approach nose, then a reversal in the ramp alignment is carried out using reverse spirals. The "wrap around" allows for proper development of superelevation in the terminal area, thereby eliminating any dangerous roll-over situation.



EXIT TERMINAL CONTROLS

MAINLINE DESIGN SPEED	RAMP DESIGN SPEED	CONTROLLING EDGE CURVE DATA				B			
		D_1	Δ_1	D_2 MIN	D_2 DES	ONE LANE MIN.	ONE LANE DES.	TWO LANE MIN.	TWO LANE DES.
UAD 40	20 25 30	1°00'	2°00'	1°00'	0°30'	270	340	270	340
UAD 50	25 30 40	1°00'	2°00'	0°45'	0°24'	300	360	300	360
UAD 60 UFD 60	25 30 40 50	1°00'	2°00'	0°24'	0°12'	360	410	360	420
UFD 70	25 30 40 50	1°00'	2°00'	0°12'	0°06'	410	470	420	480
UFD 80	30 40 50	1°00'	2°00'	0°06'		470		480	

FOR EXIT TERMINALS ON A TANGENT MAINLINE USE Δ_1, D_1 & D_2 FOR CONTROL
FOR EXIT TERMINALS ON A CURVALINEAR MAINLINE USE **DISTANCE B** FOR CONTROL

RAMP WIDTHS

	RorD	W_1	W_2
UAD	50'	23·0'	36·0'
	75'	22·0'	33·0'
	100'	21·0'	31·0'
	38°	20·0'	29·0'
	24°	19·0'	28·0'
	18°	18·0'	27·0'
	12°	18·0'	26·0'
	Tan.	17·0'	24·0'
UFD	100'	14·0'	30·0'
	38°	14·0'	28·0'
	24°	14·0'	26·0'
	18°	14·0'	25·0'
	12°	14·0'	24·0'
	Tan.	14·0'	24·0'

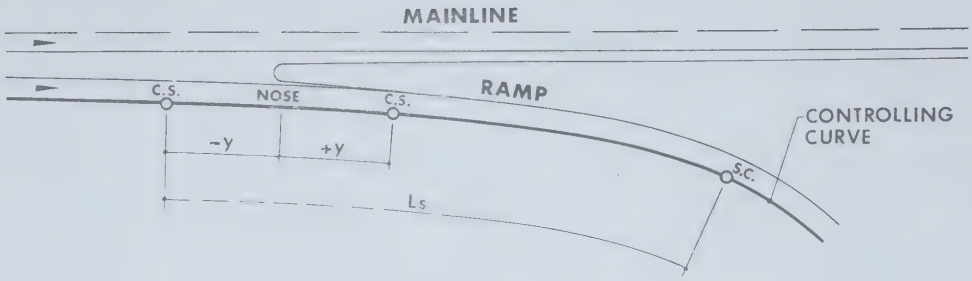
NOTES:
1. PAVEMENT LINES SHOWN ARE FOR DIMENSIONS ONLY AND DO NOT INDICATE PAINT LINES.
2. SEE EXHIBITS G-3 TO G-7 FOR APPROACH NOSE AND PAVEMENT WIDTH DETAILS.

SUGGESTED RAMP DESIGN SPEED

MAINLINE DESIGN SPEED	RAMP DESIGN SPEED			
	DESIRABLE	MINIMUM	NORMAL LOOP	MINIMUM LOOP
50	30	25	25	25
60	40	30	30	25
70	50	40	30	25
80	50	40	30	30

PROVINCE OF ALBERTA
URBAN HIGHWAY DESIGN GUIDE

EXIT TERMINALS
DESIGN CONTROLS



EXAMPLE:

(a) MAINLINE DESIGN SPEED = 70 mph; CONTROLLING CURVE ON RAMP = 25 mph. Ls = 600', Y = +70'. LOCATE C.S. 70' BEYOND APPROACH NOSE.

(b) MAINLINE DESIGN SPEED = 50 mph; CONTROLLING CURVE ON RAMP = 40 mph. Ls = 200', Y = −100'. LOCATE C.S. 100' BEFORE APPROACH NOSE.

LENGTH & LOCATION OF SPIRAL AT EXIT TERMINALS

DESIGN SPEED OF RAMP CONTROLLING CURVE			50		40		30		25		20	
DEGREE OF RAMP CONTROLLING CURVE			7°		12°		24°		38°		64°	
MAINLINE DESIGN SPEED	DESIGN SPEED AT NOSE ASSUMING A SPEED REDUCTION OF 12·5% *	35·0 % †	Ls	Y	Ls	Y	Ls	Y	Ls	Y	Ls	Y
80	70	52	300	−20	500 200	−10 −40	600 300	+100 +10				
70	61	46	200	−50	300 200	−20 −100	500 300	+10 −90	600 300	+70 −30		
60	53	39	200	−100	200	−40	300 200	+10 −90	400 200	+40 −10		
50	44	32			200	−100	200	−40	300 200	−30 −100		
40	35	30 ε					200	−100	200 200	−60 −100	200 200	−10 −70

Ls min. = 200'; Y = C − X; Y max. = ± 100'; Y des. = 0'

Calculated Y values rounded to nearest positive 10.
Negative Y values to be used only when structural cost is a major consideration, otherwise use Y des. = 0.

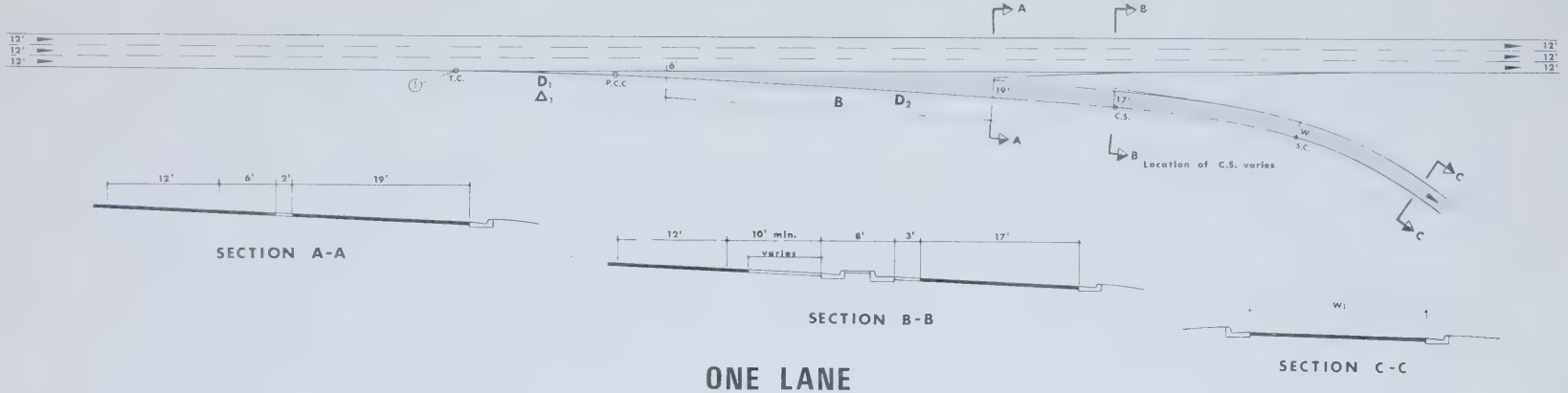
*SPEED AT APPROACH NOSE ASSUMING DRIVER IS TRAVELLING 12·5% SLOWER THAN THE MAINLINE DESIGN SPEED.

†SPEED AT APPROACH NOSE ASSUMING DRIVER IS TRAVELLING 35·0% SLOWER THAN THE MAINLINE DESIGN SPEED.

ε30 mph ASSUMED MINIMUM DESIGN SPEED AT APPROACH NOSE.

PROVINCE OF ALBERTA
URBAN HIGHWAY DESIGN GUIDE

EXIT TERMINALS
SPIRAL LOCATION

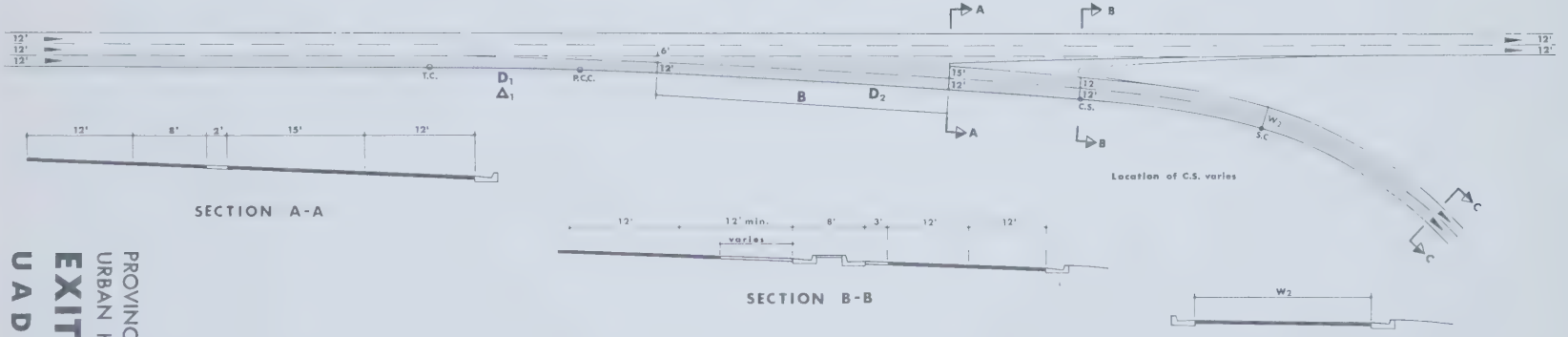


SECTION A-A

SECTION B-B

SECTION C-C

ONE LANE



SECTION A-A

SECTION B-B

SECTION C-C

TWO LANE

PROVINCE OF ALBERTA
URBAN HIGHWAY DESIGN GUIDE

EXIT TERMINALS

U A D TANGENT - U A D

LANE DROPPED

RAMP WIDTHS		
R or D	W_1	W_2
50'	23·0'	36·0'
75'	22·0'	33·0'
100'	21·0'	33·0'
38°	20·0'	29·0'
24°	19·0'	28·0'
18°	18·0'	27·0'
12°	18·0'	26·0'
Tan.	17·0'	24·0'

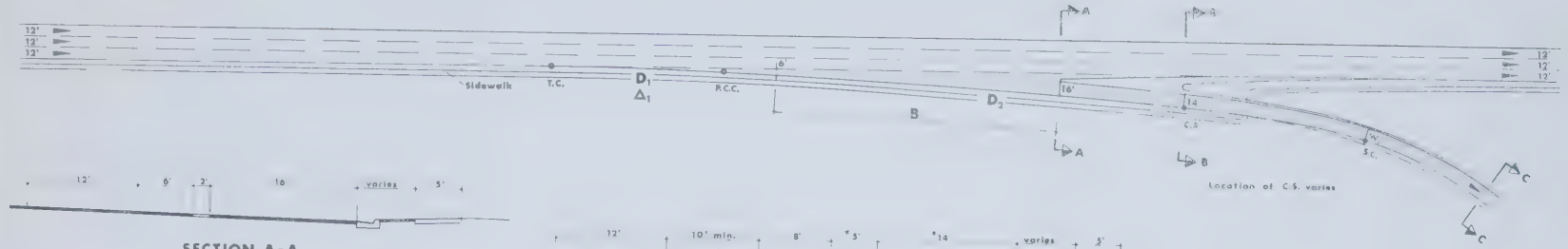
EXIT TERMINAL CONTROLS									
MAINLINE DESIGN SPEED	RAMP DESIGN SPEED	CONTROLLING EDGE CURVE DATA				B			
		D_1	Δ_1	D_2 MIN	D_2 DES	ONE LANE MIN	ONE LANE DES	TWO LANE MIN	TWO LANE DES
U A D 40	20 25 30	1°00'	2°00'	1°00'	0°30'	270	340	270	340
U A D 50	25 30 40	1°00'	2°00'	0°45'	0°24'	300	360	300	360
U A D 60	25 30 40 50	1°00'	2°00'	0°24'	0°12'	360	410	360	420

EXHIBIT G-3

PROVINCE OF ALBERTA
URBAN HIGHWAY DESIGN GUIDE

EXIT TERMINALS

U A D TANGENT - U F D



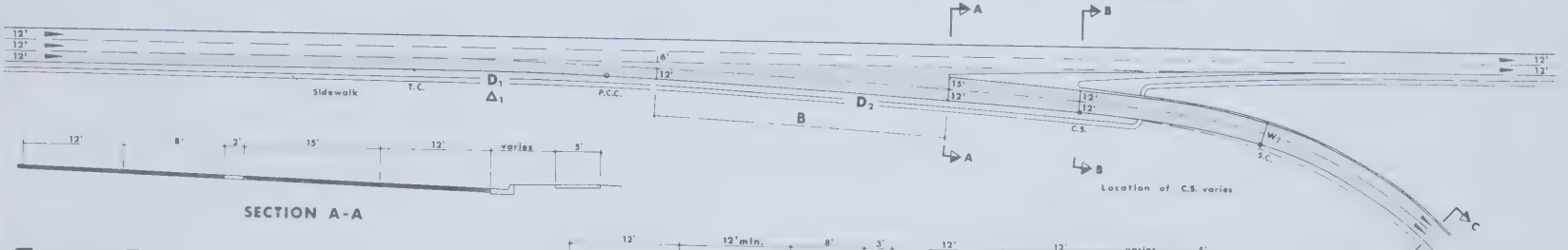
SECTION A-A

SECTION B-B

SECTION C-C

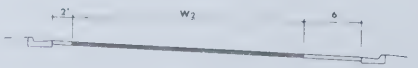
ONE LANE

NOTE:
*SHOULDER TO BE DEVELOPED ON RAMP TO ALLOW MIN. 19' EDGE TO EDGE OF GUTTER LINE.



SECTION A-A

SECTION B-B



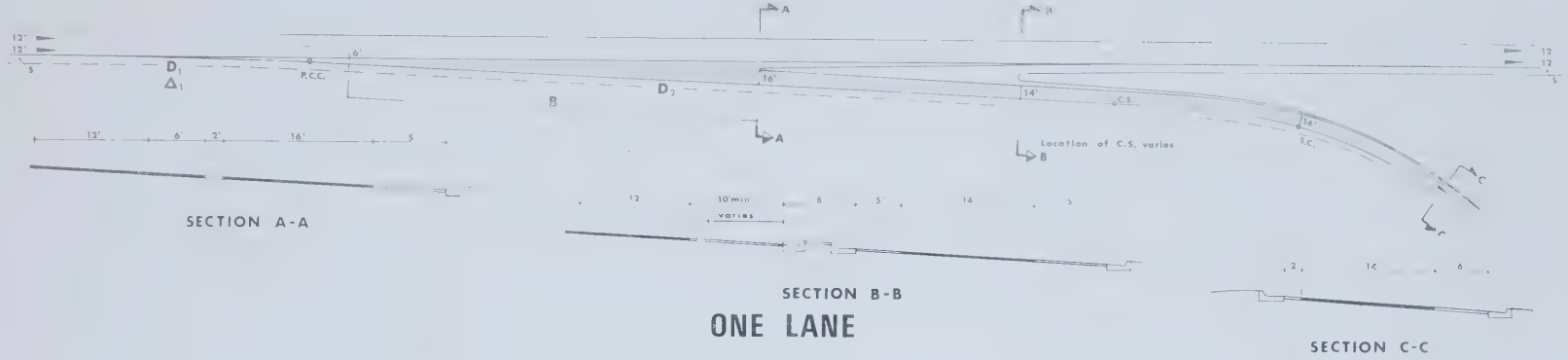
SECTION C-C

TWO LANE

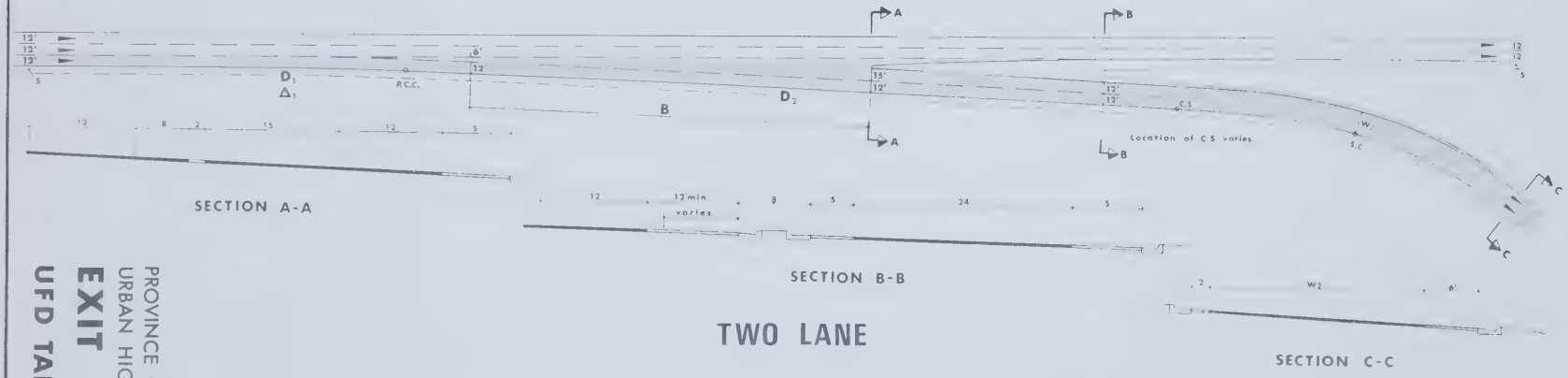
RAMP WIDTHS		
R or D	W_1	W_2
100°	14·0'	30·0'
38°	14·0'	28·0'
24°	14·0'	26·0'
18°	14·0'	25·0'
12°	14·0'	24·0'
Tan.	14·0'	24·0'

EXIT TERMINAL CONTROLS									
MAINLINE DESIGN SPEED	RAMP DESIGN SPEED	CONTROLLING EDGE CURVE DATA				B			
		D_1	Δ_1	D_2		ONE LANE		TWO LANE	
				MIN.	DES.	MIN	DES.	MIN.	DES.
U A D 40	20 25 30	1°00'	2°00'	1°00'	0°30'	270	340	270	340
U A D 50	25 30 40	1°00'	2°00'	0°45'	0°24'	300	360	300	360
U A D 60	25 30 40 50	1°00'	2°00'	0°24'	0°12'	360	410	360	420

EXHIBIT G-4



ONE LANE



TWO LANE

PROVINCE OF ALBERTA
URBAN HIGHWAY DESIGN GUIDE

EXIT TERMINALS

UFD TANGENT – UFD/UAD

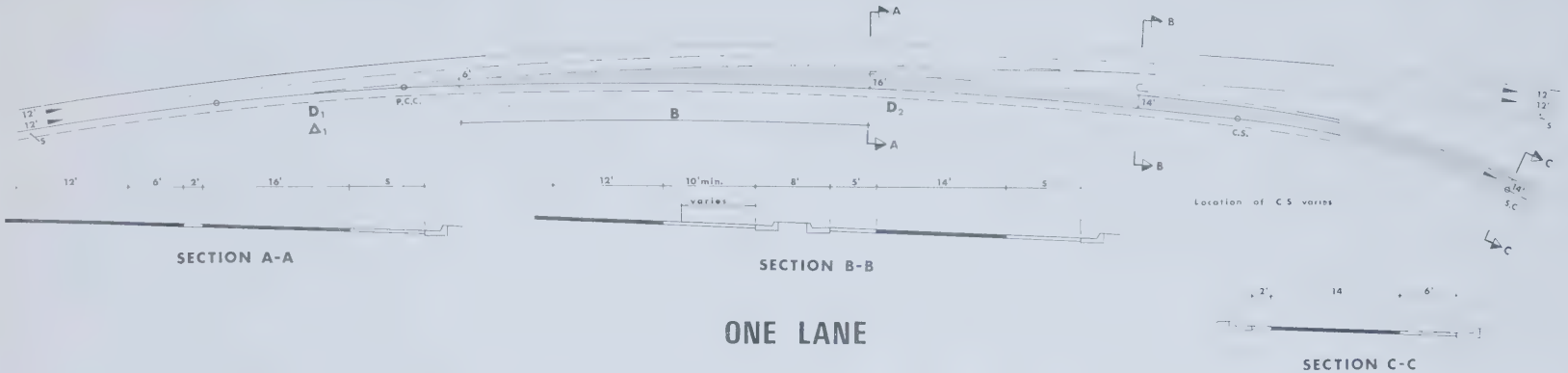
RAMP WIDTHS

R or D	W_1	W_2
100'	14·0'	30·0'
36'	14·0'	28·0'
24'	14·0'	26·0'
18'	14·0'	25·0'
12'	14·0'	24·0'
Tan.	14·0'	24·0'

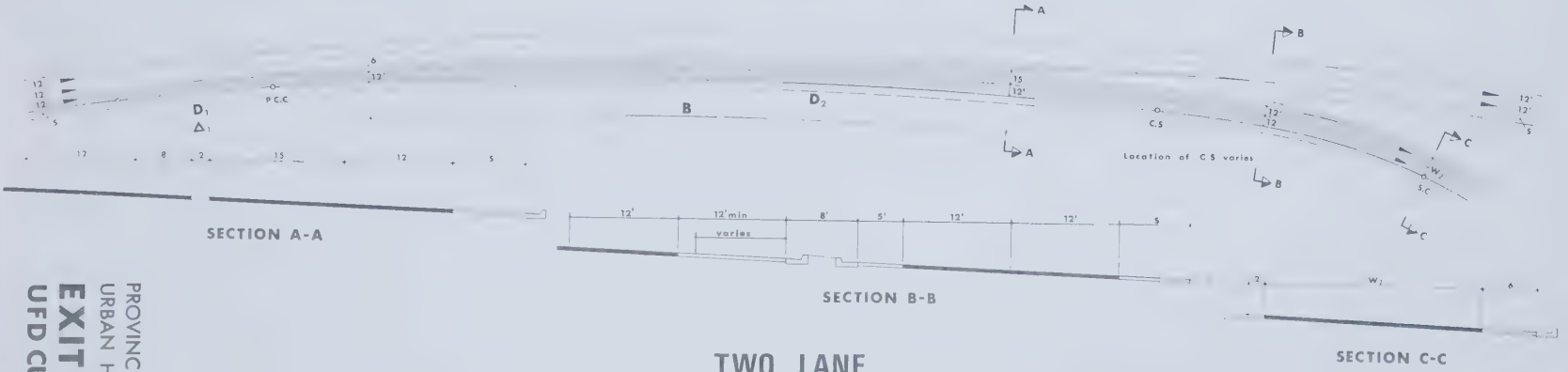
EXIT TERMINAL CONTROLS

MAINLINE DESIGN SPEED	RAMP DESIGN SPEED	CONTROLLING EDGE CURVE DATA D_1	Δ_1	D_2 MIN	D_2 DES	B ONE LANE MIN	B ONE LANE DES	B TWO LANE MIN	B TWO LANE DES
UFD 60	25 30 40 50	1°00'	2°00'	0°24'	0°12'	360	410	360	420
UFD 70	25 30 40 50	1°00'	2°00'	0°12'	0°06	410	470	420	480
UFD 80	30 40 50	1°00'	2°00'	0°06'		470		480	

EXHIBIT G-5



ONE LANE



TWO LANE

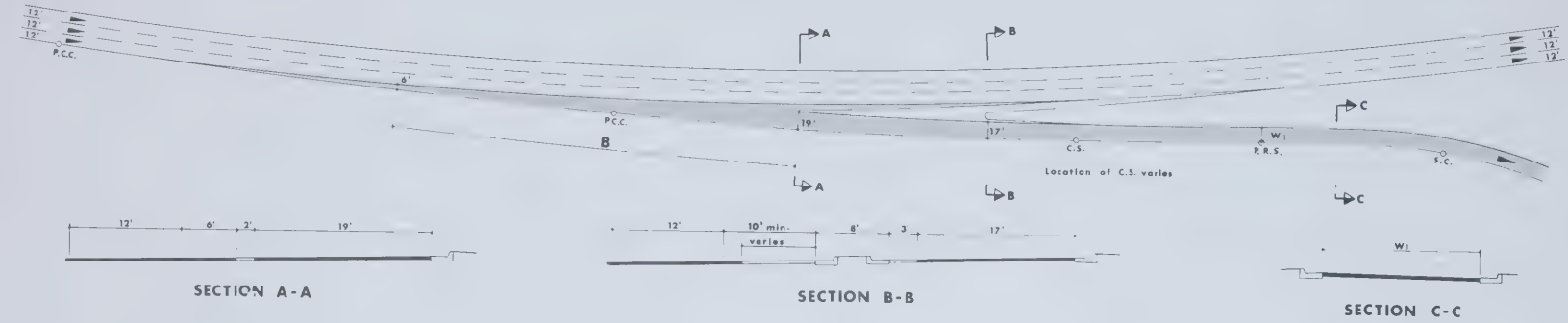
PROVINCE OF ALBERTA
URBAN HIGHWAY DESIGN GUIDE

EXIT TERMINALS
UFD CURVILINEAR-UFD/UAD

RAMP WIDTHS		
R or D	W_1	W_2
100'	14·0'	30·0'
38'	14·0'	28·0'
24'	14·0'	26·0'
18'	14·0'	25·0'
12'	14·0'	24·0'
Tan.	14·0'	24·0'

EXIT TERMINAL CONTROLS								
MAINLINE DESIGN SPEED	RAMP DESIGN SPEED	CONTROLLING EDGE CURVE DATA				B			
		D_1	Δ_1	D_2		ONE LANE		TWO LANE	
				MIN.	DES.	MIN.	DES.	MIN.	DES.
UFD 60	25 30 40 50	-	-	-	-	360	410	360	420
UFD 70	25 30 40 50	-	-	-	-	410	470	420	480
UFD 80	30 40 50	-	-	-	-	470	-	480	-

EXHIBIT G-6

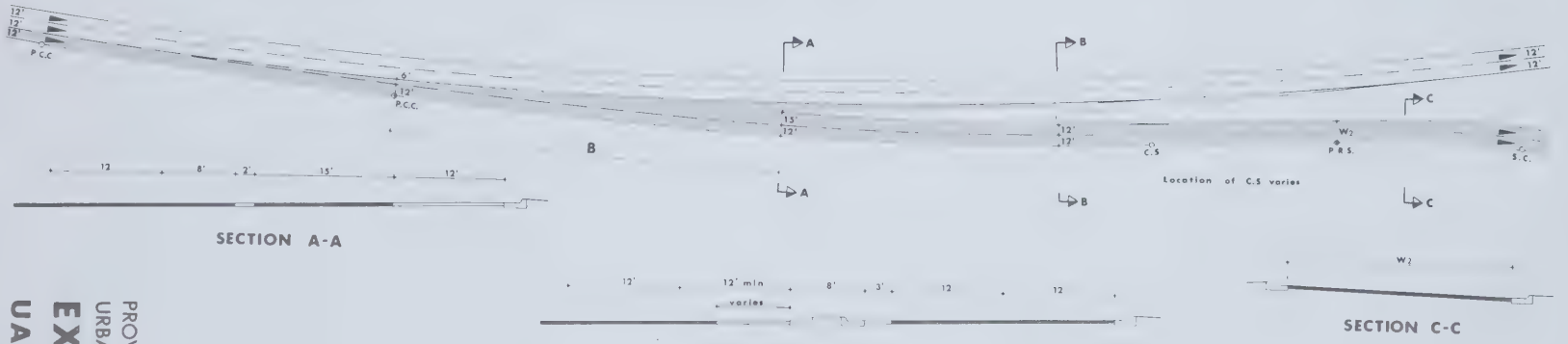


SECTION A-A

SECTION B-B

SECTION C-C

ONE LANE



SECTION A-A

SECTION B-B

SECTION C-C

TWO LANE

PROVINCE OF ALBERTA
URBAN HIGHWAY DESIGN GUIDE

EXIT TERMINALS

UAD CURVILINEAR-UAD

RAMP WIDTHS		
R or D	W_1	W_2
50°	23·0'	36·0'
75°	22·0'	33·0'
100°	21·0'	31·0'
38°	20·0'	29·0
24°	19·0'	28·0'
18°	18·0'	27·0'
12°	18·0'	26·0'
Tan.	17·0'	24·0'

EXIT TERMINAL CONTROLS									
MAINLINE DESIGN SPEED	RAMP DESIGN SPEED	CONTROLLING EDGE CURVE DATA				B			
		D_1	Δ_1	D_2 MIN.	D_2 DES.	ONE LANE MIN.	ONE LANE DES.	TWO LANE MIN	TWO LANE DES
UAD 40	20 25 30	-	-	-	-	270	340	270	340
UAD 50	25 30 40	-	-	-	-	300	360	300	360
UAD 60	25 30 40 50	-	-	-	-	360	410	360	420

EXHIBIT G-7

CHAPTER·H

ENTRANCE TERMINALS

	Page
Speed Change Lane Criteria	H.2
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Acceleration Length	
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Transition Curve Criteria	H.7
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UAD to UFD Lane-Away	

EXHIBITS

	No.
Design Controls	H-1
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UFD to UAD Tangent	H-4
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UAD/UFD to UFD Lane-Away	H-7

CHAPTER · H

ENTRANCE TERMINALS

This Chapter provides guide lines which will enable the designer to prepare standardized entrance terminal layouts compatible with the different highway classifications.

The guide lines incorporate the philosophies listed below which are desirable features of good design namely; uniformity, simplicity, operational efficiency and safety:

1. Vehicles entering the mainline must be able to travel on a "natural path".
2. In order to permit the acceleration of vehicles, from the controlling ramp curvature speed to the mainline through traffic speed, sufficient acceleration distance must be provided.
3. An adequate merging manoeuver length must be provided enabling drivers to select a gap, in the adjacent through traffic stream, and merge safely without appreciable speed interference.
4. The entrance configuration must be similar to the exit ramp configuration.

To facilitate presentation, this Chapter is broken into three parts as follows:

1. Speed Change Criteria (the portion of the entrance ramp downstream from the merging end) which includes alignment, acceleration length, merging length and wedge treatment.
2. Transition Curve Criteria (the portion of the entrance ramp between the merging end and controlling curve of the ramp)

dealing with the speed-curvature relationship on spirals and location of the spiral transition curve.

3. Typical Entrance Terminals - involving specific designs for each classification of highway.

Speed Change Lane Criteria

Alignment

A direct taper design similar to the exit configuration best fulfills the above criteria. The right edge of the ramp pavement is used as the control line for alignment design, illustrated on Exhibit H-1. The entrance or speed change lane design essentially consists of a tangential taper transitioned to the main alignment by a constant curvature (Dc) of 1-degree to facilitate a smooth entry. The taper design is produced by an angle of convergence ($\triangle$) which varies from 1-degree at 80 mph to 2 degrees and 30 minutes at 40 mph.

Acceleration Length

The acceleration length, measured from the C.S. of the entrance ramp controlling curve to the point at which the merging lane is 6 feet in width adjacent to the through lanes, must be long enough to permit vehicles entering the mainline to accelerate and merge safely with through traffic.

A spiral transition (Ls), a length of tangent (**T**), and the merge distance (**M**) make up the acceleration length (**A**); all of which are illustrated on Exhibit H-1.

The (**A**) lengths listed in the Entrance Terminal Control tables on Exhibits H-1 to H-7 inclusive consist of rounded minimum values.

Minimum acceleration distances, based on normal operating conditions - providing acceleration from the average running speed on the ramp to 5 mph less than the average mainline running speed, are indicated in Table H-1.

TABLE H-1

MINIMUM ACCELERATION LENGTHS

Mainline		Distance required to accelerate to Mainline Average Running Speed less 5 mph from							
Design Speed mph.	Speed Reached mph. [Average Running Speed less 5 mph.]	DESIGN SPEED ON RAMP							
		15	20	25	30	35	40	45	50
		INITIAL SPEED (Average Running) ON RAMP							
		14	18	22	26	30	36	40	44
40	31	320	250	220	140				
50	39	700	630	580	500	380	160		
60	47	1120	1070	1000	910	800	590	400	170
70	53	1540	1500	1410	1330	1230	1010	830	580

Table H-2 summarizes desirable acceleration distances using design speed rather than average running speed. These values are quite high and may be difficult to achieve. However, they provide a guide when seeking values above the minimum listed in Table H-1. Since average running speeds are on an upward trend higher than minimum values should be used wherever possible.

TABLE H-2

DESIRABLE ACCELERATION LENGTHS

Mainline		Distance required to accelerate to Mainline Design Speed less 5 mph from						
Design Speed mph.	Speed Reached mph. [Design Speed less 5 mph.]	DESIGN SPEED ON RAMP						
		20	25	30	35	40	45	50
		INITIAL SPEED (Design) ON RAMP						
		20	25	30	35	40	45	50
40	35	390	300	160				
50	45		800	670	480	260		
60	55		1500	1400	1200	1030	720	400
65	60		1900	1820	1650	1480	1220	930
70	65		2350	2300	2150	2000	1800	1550
75	70							2380

NOTE: All values from AASHO graph of Figure VII-18. Acceleration lengths below heavy line not to be used for design but shown for guidance only.

Acceleration lengths need also to be adjusted for grades, and ratio factors for such adjustments are detailed in Table H-3. The ratios stipulated are multiplied by the values in Tables H-1 and H-2 to obtain the required acceleration length (**A**) effected by grade changes.

Merging Length

The merging length (**M**) is the tapered distance measured from the wedge point to where the merging lane is 6 feet wide. The 6-foot dimension is used to end the **M** distance, as it represents half a lane width, in accordance with AASHO's procedure of measuring the length of a tapered acceleration lane from where the added pavement is 6 feet in width.

TABLE H-3

EFFECT OF GRADE ON ACCELERATION DISTANCE

Design Speed of Highway mph	Ratio of length on grade to length on level* for: Design speed of turning roadway curve, mph				
	20	30	40	50	All Speeds
	3 to 4% upgrade				3 to 4% downgrade
40	1.3	1.3			0.7
50	1.3	1.4	1.4		0.65
60	1.4	1.5	1.5	1.6	0.6
70	1.5	1.6	1.7	1.8	0.6
	5 to 6% upgrade				5 to 6% downgrade
40	1.5	1.5			0.6
50	1.5	1.7	1.9		0.55
60	1.7	1.9	2.2	2.5	0.5
70	2.0	2.2	2.6	3.0	0.5

*Ratio from this table multiplied by length in Table H-1 or H-2 gives minimum or desirable length respectively of speed change lane on grade.

The development of the merging length is premised on three controls:

1. The time required to find and enter an acceptable gap.
2. Angle of convergence (Δ).
3. The width of the pavement at the wedge point.

Table H-4 illustrates the time available for drivers to select an available gap and merge safely, without appreciable speed interference to the mainline through traffic, in relation to the provision of various adequate merging lengths and average merging speeds. The minimum merge distances, listed on Exhibit H-1 provide a merging time of 8 seconds, based on an average merging speed 10 mph less than the mainline design speed.

TABLE H-4

MERGING TIME

Angle of Convergence (△)	1°-00'	1°-15'	1°-30'	2°-00'	2°-30'
Merging Length (**M**)	690'	550'	460'	350'	290'
Highway Classification	UFD 70	UFD 60	UAD 50	UAD 40	UAD 40
Average Merging Speed *	Merging Time in Seconds				
60 mph	8	6			
50	10	8	8	7	
40	12	10	8	7	
30		12	10	8	7

* Assuming the vehicle averages this speed over the '**M**' distance.

A minimum convergence angle (△) of 1-degree, which produces a corresponding merge length of 690 feet, should be maintained for 70 and 80 mph freeway designs allowing for heavy traffic conditions generally associated with urban freeways.

The width of the entrance ramp is widened or flared between the merging end and the 2-foot wedge point in order to give the motorist some flexibility of driving path when approaching the merge area. Width of ramp and ramp widening are tabulated and illustrated respectively on Exhibit H-1; also listed in tabular form the values of (△) and corresponding **M** lengths appropriate for the various highway classifications and ramp design speeds.

Wedge Treatment

The wedge is the pavement area between the ramp proper and the through lanes, measured from the curb return of the merging end

to the wedge point, as illustrated on Exhibit H-1. Table H-5 details the wedge length (**Lw**) for freeway and arterials assuming the S.T. is located at the merging end. For freeway designs employing flat convergence angles the wedge lengths become quite long but this additional distance is beneficial in providing adequate acceleration length. Details on the latter as well as on the subject of the spiral to tangent location, which may be adjusted to reduce wedge lengths, are expanded upon in the next section under the heading of "Transition Curve Criteria".

TABLE H-5
WEDGE LENGTH

Highway Classification	Convergence Angle (Δ)	Shoulder Width	Minimum Merging Distance (**M**)	Wedge Length (**Lw**)
UFD 70	1-00'	8'	690'	800'
UFD 60	1-15	8	550	640
UAD 50	1-30	-	500	150
UAD 40	2-30	-	300	90

Transition Curve Criteria

Speed Curvature Relationship on Spirals

Spirals are used to provide a smooth transition between the controlling curvature of the ramp and the tangential taper of the acceleration lane. The design speed at any point on the spiral is dependent on the equivalent curvature at that point and the equivalent curvature varies proportionately as the distance increases from the beginning of spiral. Speed control points similar to those calculated for exit terminals are illustrated by Figure H-1 and listed in Table H-6 for a 38 degree controlling curve with varying spiral lengths.

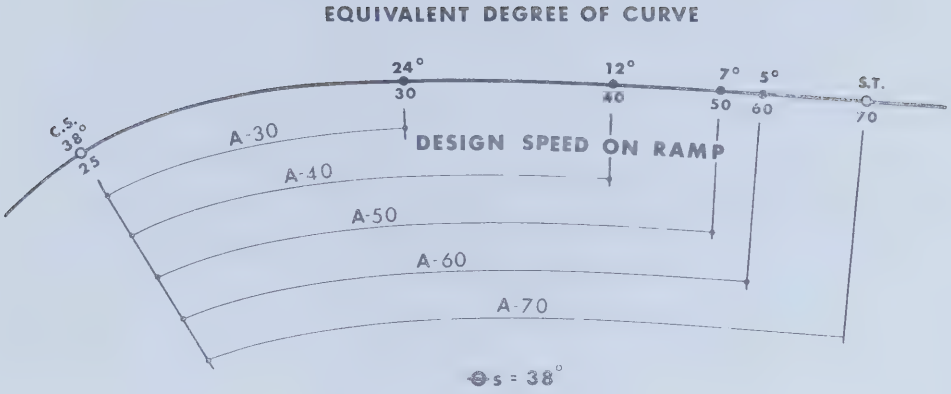


FIGURE H-1

TABLE H-6

DISTANCES FROM C.S. TO SPEED CONTROL POINT ON THE SPIRAL

Controlling Curve	Spiral Length Ls	Control Points				
		A_{25}	A_{30}	A_{40}	A_{50}	A_{60}
Dc = 38°	200'	0	73	137	163	185
	300'	0	110	205	244	260
25 mph	400'	0	147	273	325	368

When the distances of Table H-6 are checked against the required acceleration lengths in AASHO, Figure VII-18, or interpolated in Tables H-1 and H-2, it is apparent that acceleration distance controls and the speed curvature relationship is not a governing factor in entrance terminal design.

Example

Given: Controlling ramp curvature = 38 degrees
Spiral length = 400 feet

Determine distance required to accelerate to 40 mph and whether acceleration distance or spiral length governs. From Table H-6, distance from C.S. to speed control point A_{40} (equivalent curvature 12 degrees) equals 273 feet. Distance required to accelerate from controlling 38 degree curve (25 mph) to equivalent 12 degree curve (40 mph) is 520 feet, graph of Figure VII-18 (AASHO). Therefore the acceleration distance governs and the spiral length does not limit the speed.

A minimum length of spiral, 200 feet, is required to produce an effective transition. Longer spirals should be used wherever practical in order to begin the acceleration (curve to spiral) further upstream on the controlling curve. The location of spiral to tangent with respect to the merging end and wedge length must however be kept in mind when considering the above.

Location of Spiral Transition Curve

The location of the spiral transition from the controlling curvature of the ramp to the entrance terminal is flexible. As a general guide the spiral to tangent (S.T.) may be placed as follows:

80 mph - Entire spiral in advance of the merging end. (Exhibit H-3, Section B-B).

70 mph - Two-thirds or more of the spiral in advance of the merging end.

60 mph - One-half or more of the spiral in advance of the merging end.

(In no case should the S.T. be located beyond the wedge point).

Adjusting the spiral to tangent between the merging end and the wedge point varies the wedge length (**Lw**) since the merging end shifts location relative to the S.T.

Typical Entrance Terminals

Entrance Design

Exhibits H-2 to H-7 illustrate different types of entrance terminals for UAD and UFD highways. Since it is not possible to cover every situation, these examples serve as a guide for other types that may be encountered. The information shown includes cross-sections at key points, offset dimensions, ramp widths and wedge treatment.

As discussed in Chapter E, if a ramp either exits from or enters onto a freeway, it should be of the UFD type. Therefore, it is possible to have a UAD highway entrance terminal with either a UAD type ramp (no shoulders) or a UFD type ramp (with shoulders).

UAD to UAD Tangent

Exhibit H-2 illustrates typical entrance terminal designs for a ramp from a UAD street to another UAD street. Since UAD streets are involved throughout, no shoulders are provided.

In order to provide the motorist with more flexibility of driving path and to establish the proper merging length (**M**), constant ramp widths of 17 feet and 28 feet are maintained between Sections B-B and C-C for 1-lane and 2-lane entrance terminal ramps respectively. The ramp width at Section A-A depends upon the ramp curvature and is obtained from the table of Ramp Widths provided on the exhibit.

UAD/UFD to UFD Tangent

Exhibit H-3 illustrates typical entrance terminal designs for a ramp from a UAD or UFD type highway to another freeway. As this is an entrance to a freeway, a shoulder is provided on the ramp.

The driving portion of Section C-C is made 2 feet wider than at Section B-B on both 1-lane and 2-lane entrance terminal ramps to provide driving flexibility and an adequate merging length. The wedge length of Exhibit H-3 is greater than that of Exhibit H-2 due to the provision of shoulders on the freeway.

UFD to UAD Tangent

Exhibit H-4 illustrates typical entrance terminal ramp designs from a freeway to a UAD street. Because of freeway involvement a full shoulder is provided on the ramp, up to where the merging end pavement is 6 feet in width. The shoulder is then tapered out beyond this location. Such an arrangement provides the motorist with greater latitude to complete his merging operation. When space does not permit this desirable treatment the shoulder may be tapered out at any point beyond Section B-B.

Curvilinear Entrance Terminals

Typical curvilinear entrance terminal designs are shown by Exhibits H-5 and H-6. Although the designs indicated are for specific UFD and UAD highways respectively, the basic method is interchangeable. In each case compound curves and spirals are used to establish proper **(M)** and **(A)** lengths.

The entrance terminal of Exhibit H-5 is the most difficult to produce, as it is necessary to develop a "wrap around" design.

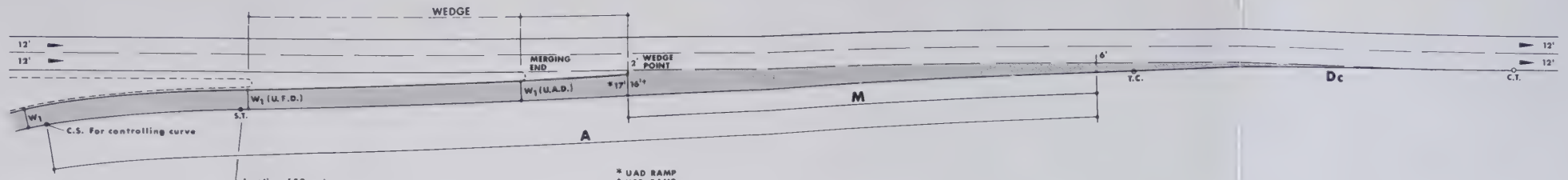
This is accomplished by curving the acceleration lane transition in the same direction as the mainline curvature until upstream from the merging end, then employing reverse spirals on the ramp to obtain a reversal in alignment. The "wrap around" design, in the terminal area, permits proper superelevation development thus avoiding any undesirable pavement roll-over situation.

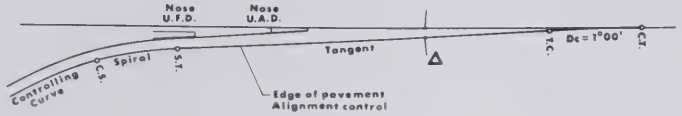
UAD to UFD Lane-Away

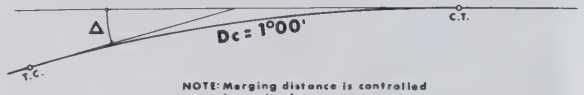
Exhibit H-7 illustrates how a lane is added to the freeway through lanes from a connecting entrance terminal. Although somewhat unusual, this situation may occur where two major facilities connect.

Sections A-A and B-B employ the standard ramp widths, whereas Section C-C is maintained at or reduced to 12 feet. Motorists are thus encouraged to remain in their respective lanes as the merging operation is not necessary. This is accomplished by compounding the required curve (Dc) with the controlling curve of the ramp and providing a spiral transition between the two curves. A flat entry angle is still required to:

1. permit acceleration prior to the wedge point
2. minimize the speed differential
3. permit safe lane change maneouvers downstream from the entrance ramp between the two traffic flows.

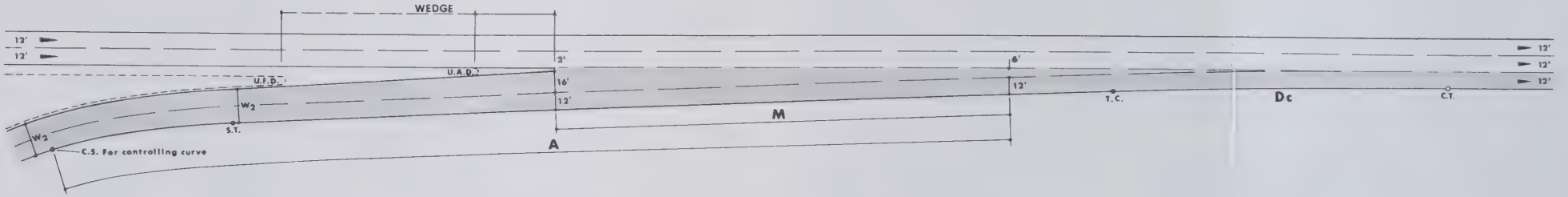






NOTE: Merging distance is controlled by angle of convergence on tangent alignment.

Δ – Angle of convergence



ENTRANCE TERMINAL CONTROLS

MAINLINE DESIGN SPEED	RAMP DESIGN SPEED	A ACCEL'N. LENGTH MIN.	A ACCEL'N. LENGTH DES.	M – MERGING DISTANCE Δ – ANGLE OF CONVERGENCE MINIMUM Δ	MINIMUM M	DESIRABLE MINIMUM Δ	DESIRABLE MINIMUM M
UAD 40	20	250	390	2°30	290	2°00	350
	25	220	300				
	30	140	160				
UAD 50	25	580	800	2°00	350	1°30	460
	30	500	670				
	35	380	480				
UFD 60	25	1000	1500	1°15	550	1°00	690
	30	910	1400				
	35	800	1200				
	40	590	1030				
	45	400	720				
UFD 70	25	1410	2350	1°00	690	–	–
	30	1330	2300				
	35	1230	2150				
	40	1010	2000				
	45	830	1800				
	50	580	1550				
UFD 80	25	1860		1°00	690	–	–
	30	1780					
	35	1700					
	40	1500					
	45	1360					
	50	1140					
	55	920					
	60	640					

FOR ENTRANCE TERMINALS ON A TANGENT MAINLINE USE Δ FOR CONTROL
FOR ENTRANCE TERMINALS ON A CURVALINEAR MAINLINE USE **DISTANCE M** FOR CONTROL

NOTE:
SEE EXHIBITS H-2 TO H-7 FOR MERGING END AND WEDGE POINT DETAILS.

	RAMP WIDTHS R or D	W_1	W_2
UAD	50'	23-0'	36-0'
	75'	22-0'	33-0'
	100'	21-0'	31-0'
	38°	20-0'	29-0'
	24°	19-0'	28-0'
	18°	18-0'	27-0'
	12°	18-0'	26-0'
	Tan.	17-0'	24-0'
UFD	100'	14-0'	30-0'
	38°	14-0'	28-0'
	24°	14-0'	26-0'
	18°	14-0'	25-0'
	12°	14-0'	24-0'
	Tan.	14-0'	24-0'

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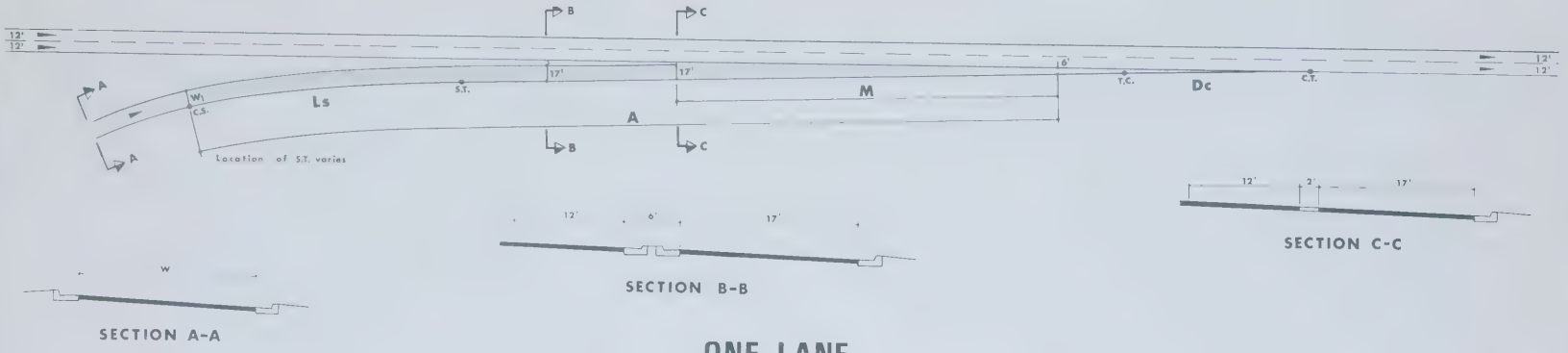
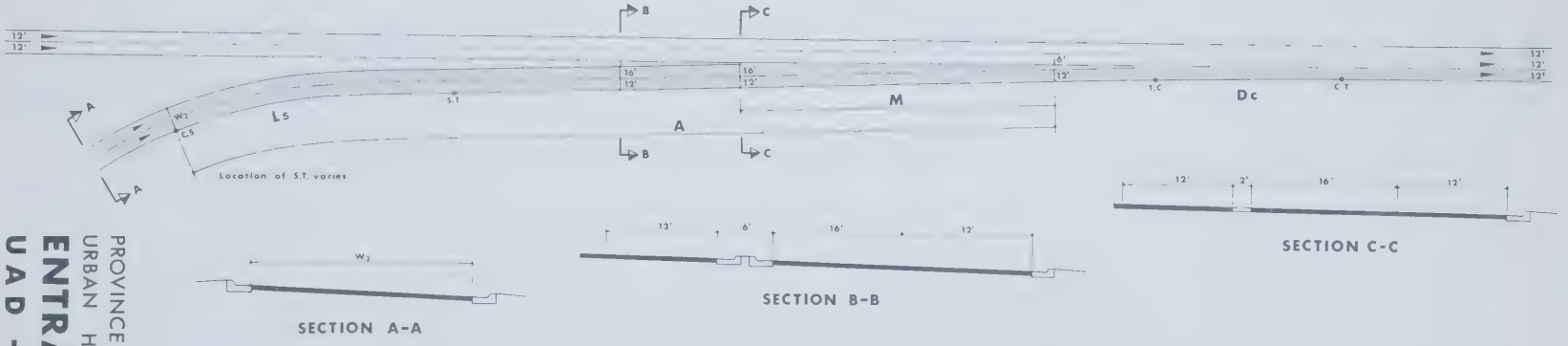
ENTRANCE TERMINALS
DESIGN CONTROLS



ONE LANE



TWO LANE

RAMP WIDTHS		
R or D	W	W
50	23·0'	36·0
75'	22·0'	33·0
100'	21·0'	31·0'
38'	20·0'	29·0'
24'	19·0'	28·0'
18'	18·0'	27·0
12'	18·0'	26·0
Tan	17·0'	24·0'

ENTRANCE TERMINAL CONTROLS						
MAINLINE DESIGN SPEED	RAMP DESIGN SPEED	A ACCEL'N MIN.	M - MERGING DISTANCE Δ - ANGLE OF CONVERGENCE			
			MINIMUM		DESIRABLE MINIMUM	
			Δ	M	Δ	M
UAD 40	20	250	2°30'	290	2°00'	350
	25	220				
	30	140				
UAD 50	25	580	1°30	400	1°15'	550
	30	500				
	35	380				

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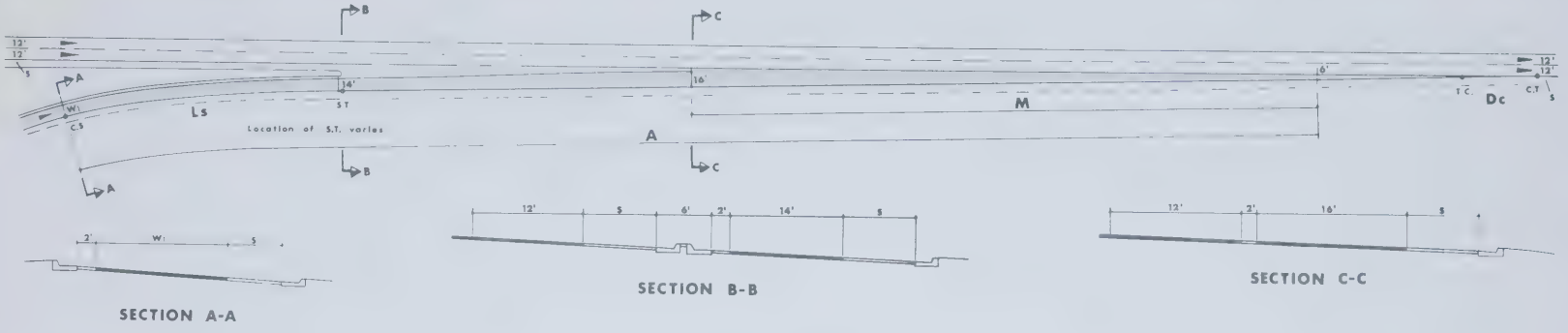
ENTRANCE TERMINALS
UAD - UAD TANGENT

EXHIBIT H-2

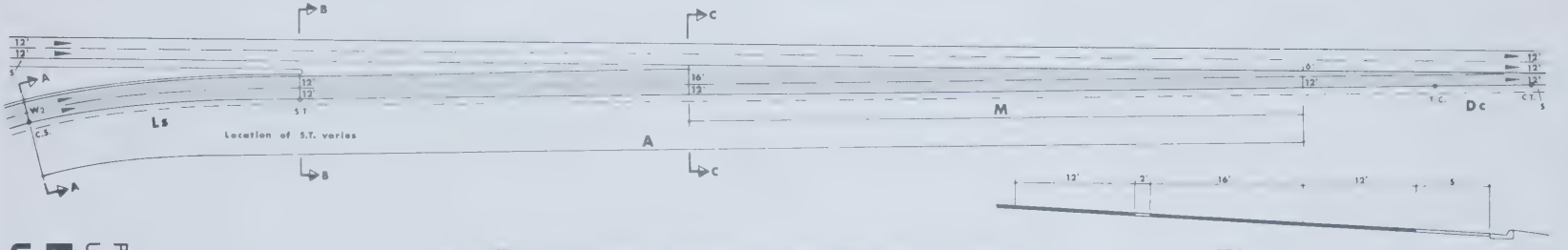


SECTION A-A

SECTION B-B

SECTION C-C

ONE LANE



SECTION C-C

SECTION B-B

SECTION A-A

TWO LANE

RAMP WIDTHS		
R or D	W_1	W_2
100°	14·0'	30·0'
38°	14·0'	28·0'
24°	14·0'	26·0'
18°	14·0'	25·0'
12°	14·0'	24·0'
Tan.	14·0'	24·0'

ENTRANCE TERMINAL CONTROLS						
MAINLINE DESIGN SPEED	RAMP DESIGN SPEED	A ACCEL'N. MIN.	M - MERGING DISTANCE Δ - ANGLE OF CONVERGENCE			
			MINIMUM		DESIRABLE MINIMUM	
			Δ	M	Δ	M
UFD 60	25	1000	1° 15'	550	1°00'	690
	30	910				
	35	800				
	40	590				
	45	400				
UFD 70	25	1410	1°00'	690	-	-
	30	1330				
	35	1230				
	40	1010				
	45	830				
	50	580				
UFD 80	30	1780	1°00'	690	-	-
	40	1500				
	50	1140				

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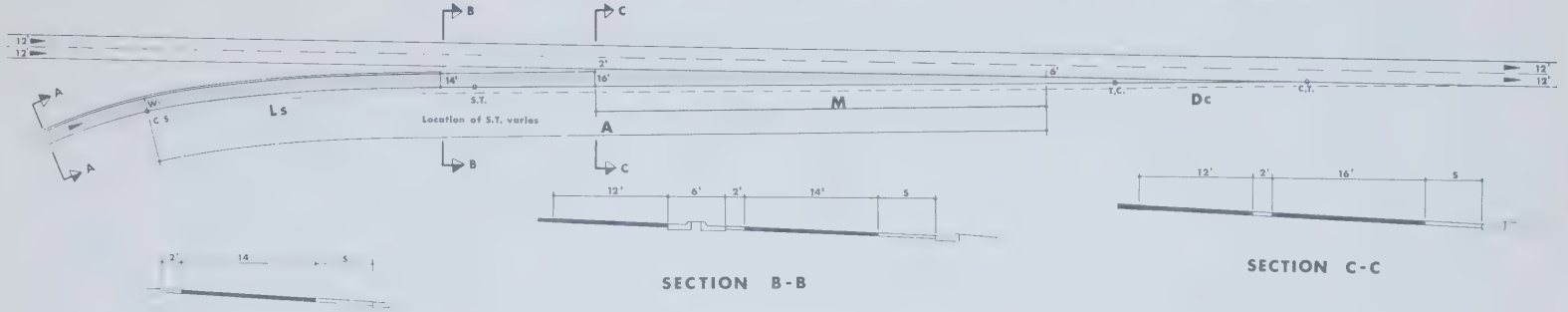
ENTRANCE TERMINALS
U A D / U F D - U F D TANGENT

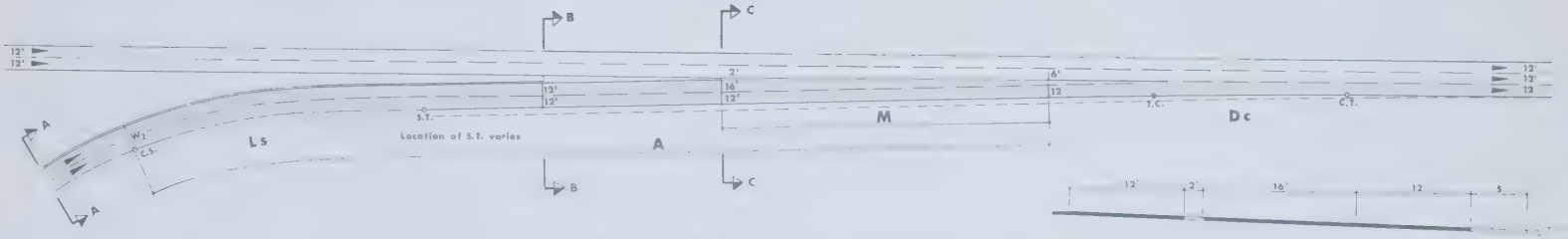


SECTION B-B

SECTION C-C

SECTION A-A

ONE LANE



SECTION B-B

SECTION C-C

SECTION A-A

TWO LANE

RAMP WIDTHS		
R or D	W_1	W_2
100'	14·0'	30·0'
38'	14·0'	28·0'
24'	14·0'	26·0'
18	14·0'	25·0'
12'	14·0'	24·0'
Tan.	14·0'	24·0'

ENTRANCE TERMINAL CONTROLS						
MAINLINE DESIGN SPEED	RAMP DESIGN SPEED	A ACCEL'N. MIN.	M - MERGING DISTANCE Δ - ANGLE OF CONVERGENCE			
			MINIMUM		DESIRABLE MINIMUM	
			Δ	M	Δ	M
U A D 40	20	250	2°30'	290	2°00'	350
	25	220				
	30	140				
U A D 50	25	580	1°30'	460	1°15	550
	30	500				
	35	380				

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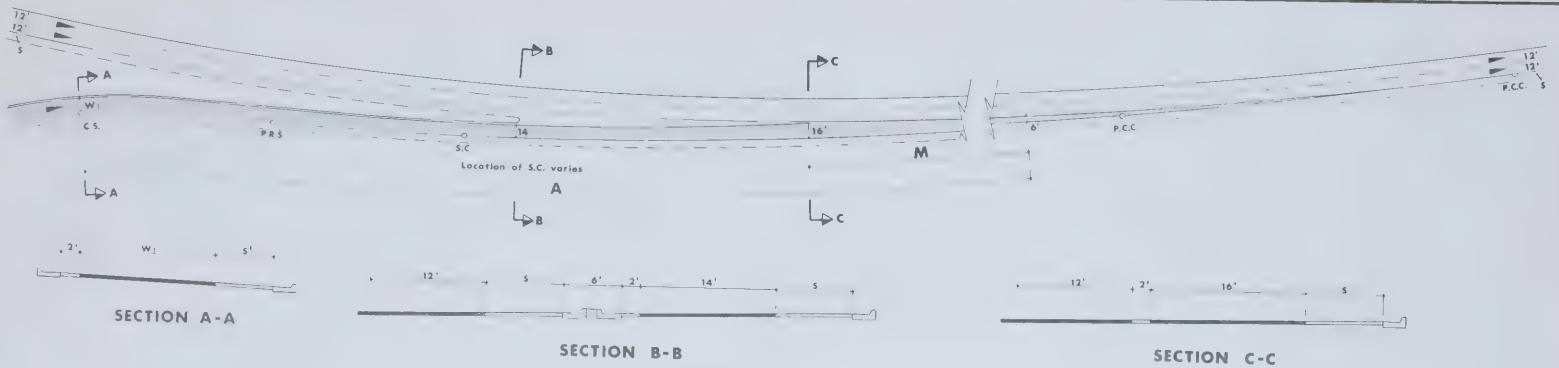
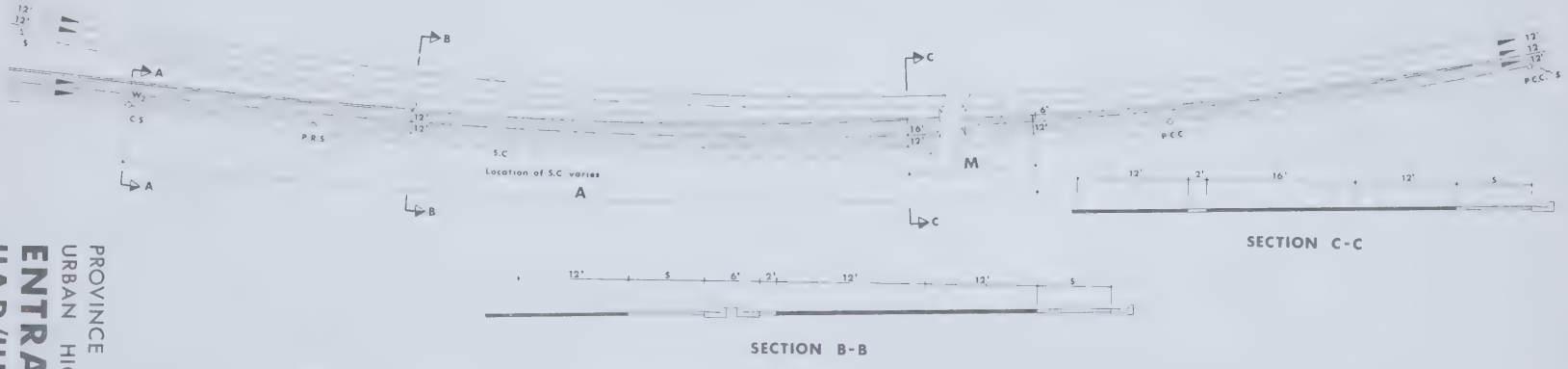
ENTRANCE TERMINALS
U F D - U A D TANGENT

EXHIBIT H-4



ONE LANE



TWO LANE

RAMP WIDTHS		
R or D	W_1	W_2
100°	14·0'	30·0'
38°	14·0'	28·0'
24°	14·0'	26·0'
18°	14·0'	25·0'
12°	14·0'	24·0'
Tan.	14·0'	24·0'

ENTRANCE TERMINAL CONTROLS						
MAINLINE DESIGN SPEED	RAMP DESIGN SPEED	A ACCEL'N MIN.	M - MERGING DISTANCE Δ - ANGLE OF CONVERGENCE			
			MINIMUM		DESIRABLE MINIMUM	
			Δ	M	Δ	M
UFD 60	25	1000	1°15'	550	1°00'	690
	30	910				
	35	800				
	40	500				
	45	400				
UFD 70	25	1410	1°00'	690	-	-
	30	1330				
	35	1230				
	40	1010				
	45	830				
	50	580				
UFD 80	30	1780	1°00'	690	-	-
	40	1500				
	50	1140				

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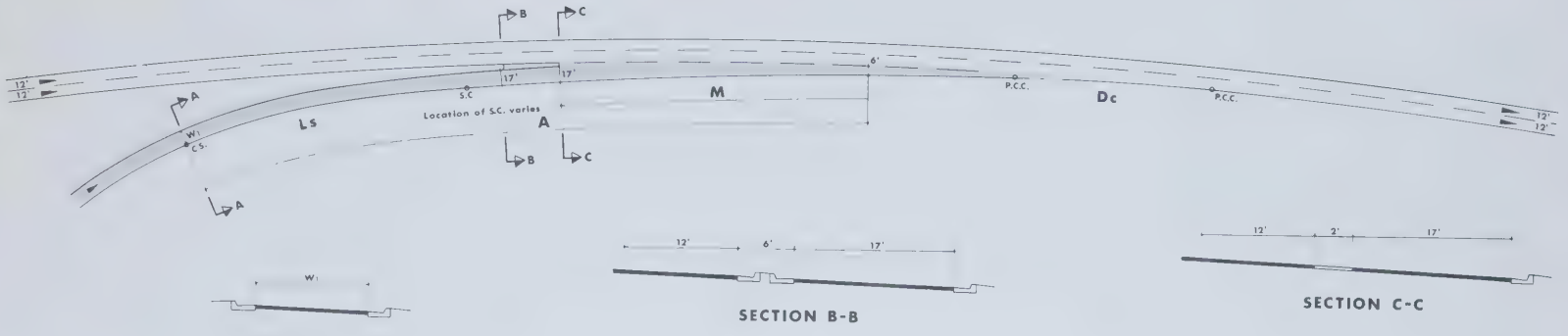
ENTRANCE TERMINALS
UA D/UFD-UFD CURVILINEAR

EXHIBIT H-5

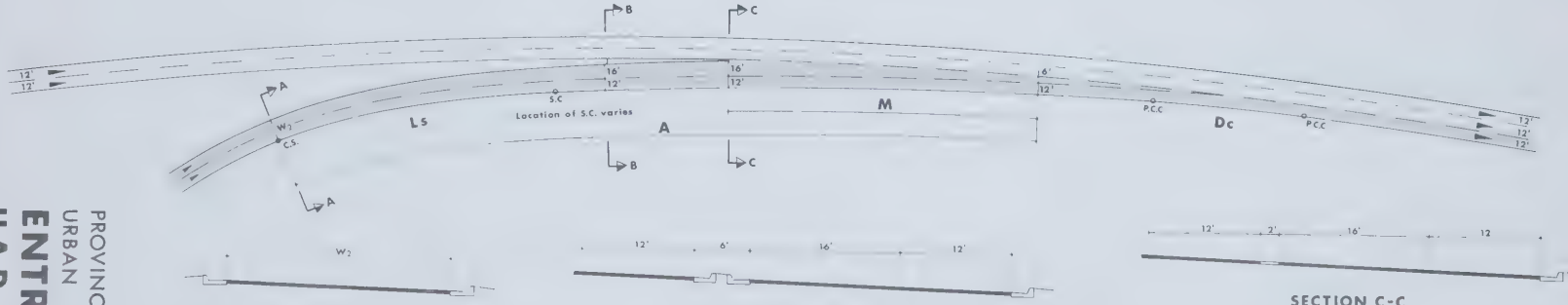


SECTION A-A

SECTION B-B

SECTION C-C

ONE LANE



SECTION A-A

SECTION B-B

SECTION C-C

TWO LANE

RAMP WIDTHS		
R or D	W_1	W_2
50°	23·0'	36·0'
75°	22·0'	33·0'
100°	21·0'	31·0'
38°	20·0'	29·0'
24°	19·0'	28·0'
18°	18·0'	27·0'
12°	18·0'	26·0'
Tan.	17·0'	24·0'

ENTRANCE TERMINAL CONTROLS						
MAINLINE DESIGN SPEED	RAMP DESIGN SPEED	A ACCEL'N. MIN	M - MERGING DISTANCE Δ - ANGLE OF CONVERGENCE			
			MINIMUM		DESIRABLE MINIMUM	
			Δ	M	Δ	M
U A D 40	20	250	-	290	-	350
	25	220				
	30	180				
U A D 50	25	580	-	350	-	460
	30	500				
	35	380				

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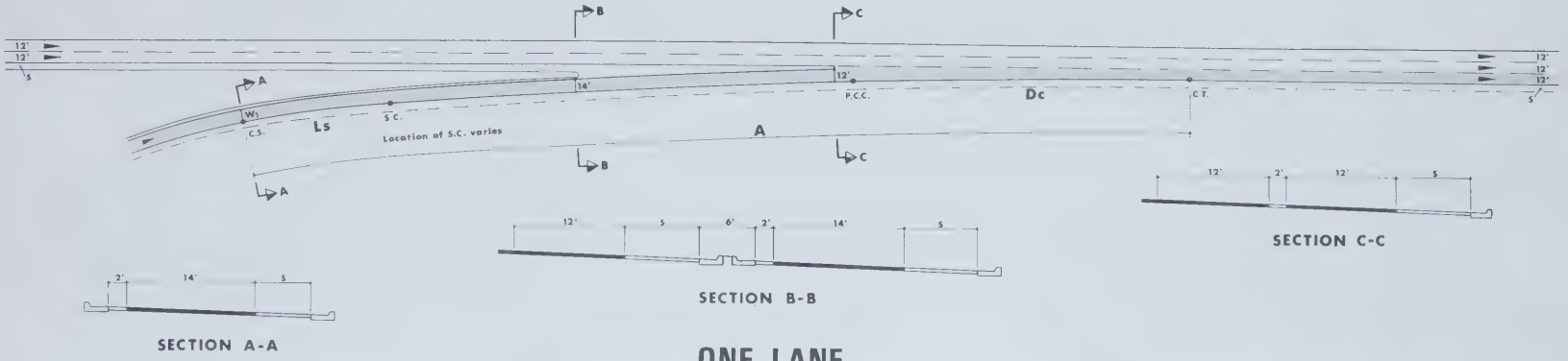
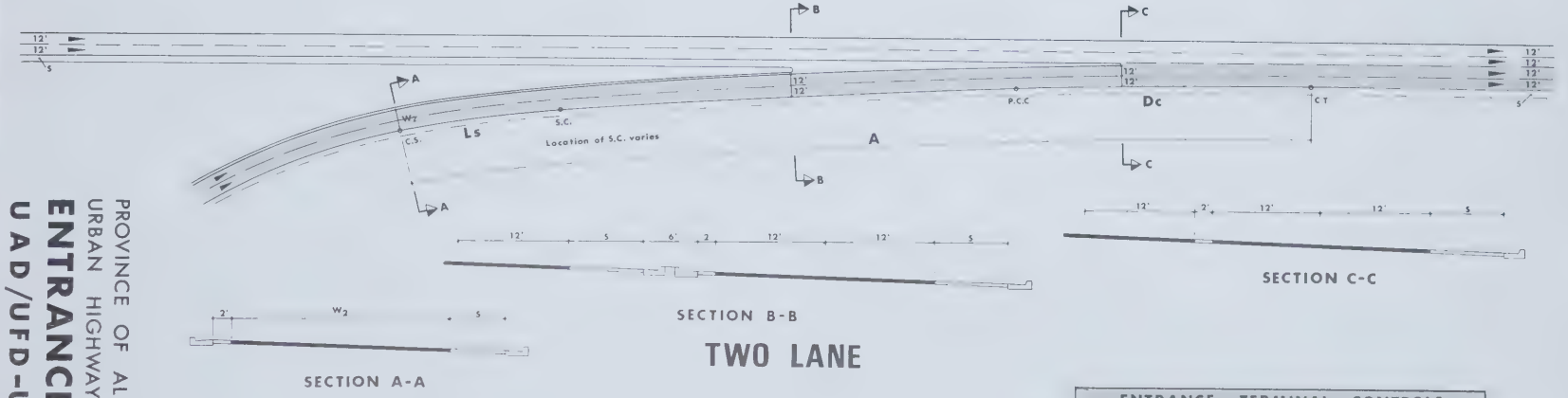
ENTRANCE TERMINALS
U A D - U A D CURVILINEAR

EXHIBIT H-6



ONE LANE



TWO LANE

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URBAN HIGHWAY DESIGN GUIDE

ENTRANCE TERMINALS

U AD/UFD-UFD LANE AWAY

RAMP WIDTHS		
R or D	W_1	W_2
100'	14·0'	30·0'
38°	14·0'	28·0'
24°	14·0'	26·0'
18°	14·0'	25·0'
12°	14·0'	24·0'
Tan.	14·0'	24·0'

NOTE:
DISTANCE **A** AND **M** NOT CRITICAL FOR LANE AWAY DESIGN. SMOOTH TRANSITION FROM RAMP CURVATURE TO LANE AWAY SHOULD BE DEVELOPED.

ENTRANCE TERMINAL CONTROLS						
MAINLINE DESIGN SPEED	RAMP DESIGN SPEED	A ACCEL'N. MIN	M - MERGING DISTANCE Δ - ANGLE OF CONVERGENCE			
			MINIMUM		DESIRABLE MINIMUM	
			Δ	M	Δ	M
UFD 60	25	1000	1°15'	550	1°00'	690
	30	910				
	35	800				
	40	590				
	45	400				
UFD 70	25	1410	1°00'	690	-	-
	30	1330				
	35	1230				
	40	1010				
	45	830				
	50	580				
UFD 80	30	1780	1°00'	690	-	-
	40	1500				
	50	1140				

EXHIBIT H-7

CHAPTER · I

TYPICAL LOOP RAMP DESIGN

	Page
Design Controls	I.1
Typical Loop Ramps	I.4
UAD 40 To UAD 40	
UFD 70 To UAD 40	

EXHIBITS

	No.
Typical Loop Ramps	
UAD 40 To UAD 40	I-1
UFD 70 To UAD 40 (Speed Reduction 12.5%)	I-2
UFD 70 To UAD 40 (Speed Reduction 35.0%)	I-3

CHAPTER · I

TYPICAL LOOP RAMP DESIGN

A loop is usually the most difficult ramp design to produce due to numerous controls, which must be exercised and developed in conjunction with one another, listed as follows:

(a) exit and entrance terminal design

(b) controlling curvature

(c) spiral transitions

(d) extra travel distance involved

(e) land area available

Design Controls

The loop ramps developed in this Manual consist of one controlling curve equal to 38 degrees based upon a 25 mph design speed, which is the most commonly utilized loop ramp speed in urban areas.

In order to encourage driver adaptability to loop designs a speed transition should be provided at each end of the ramp enabling a motorist to maintain both a constant turning motion and speed once on the controlling curve portion of the ramp itself. Therefore, the loop ramp design advocated consists of exit and entrance terminals, in accordance with the standards developed in Chapters G and H, one controlling curve and two spiral transitions as shown in Figure I-1.

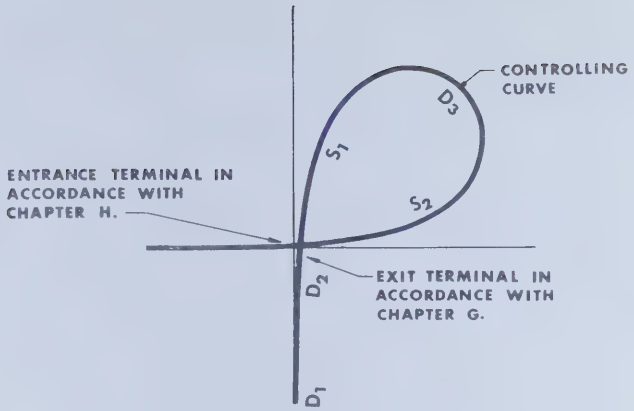


FIGURE I-1

The exit terminal spiral (S_1) is positioned by the use of the **Y** distance, from Exhibit G-2, so that the combination of spiral length and **Y** distance provide an adequate deceleration length, allowing the driver to decelerate from his exit speed at the approach nose to the controlling curve speed. Once on the controlling curve (D_3) it is assumed the vehicle continues at a constant speed until the entrance terminal spiral (S_2) is reached. The driver may then begin accelerating to enter the merge area.

Although the usage of these criteria will for most cases produce a loop of sufficient length to effect the required difference in elevation between the intersecting highways, the ramp profile should be checked to ensure that a gradient in excess of 6 percent is not exceeded. When ramp terminals are located on appreciable grades a larger controlling curvature may be required to meet the gradient limitations. Only for the special case of limited sight conditions should a gradient in excess of 6 percent be considered since the provision of adequate sight distance is of greater importance than gradient control.

As the usual form of any ramp profile corresponds with the letter **S**, major changes in gradient are made by two vertical curves - a sag at the lower terminal and a crest at the upper one, hence vertical sight control depends largely on conditions at the terminals themselves. Motorists exiting from the through highway lanes to enter a descending loop ramp may have their view of the critical horizontal curvature limited by a crest vertical curve. In such cases this initial vertical curve should be designed so the beginning of the critical horizontal curvature (S.C.) is obvious to the driver. When this situation cannot be attained, the vertical curve provided should be greater than required for the stopping sight distance. Likewise for the condition of an ascending loop ramp at an entrance terminal, to the through highway lanes, a clear view of both the highway and the merging length (M) is essential.

For information pertaining to profile design procedure of loop ramps the reader is directed to page 537 of AASHO (Blue Book - 1965).

TABLE I-1

LOOP RAMP DESIGN SPIRAL CRITERIA

Mainline Design Speed	Design Speed at Approach Nose Assuming Speed Reduction of		Controlling Loop Curvature 38-degrees	
	12.5%	35%	Ls	Y
70	61		600	+70
		46	300	-30
60	53		400	+40
		39	200	-10
50	44		300	-30
		32	200	-100
40	35		200	-60
		30&	200	-100

& 30 mph assumed minimum design speed at approach nose.
Negative **Y** values to be used only when structural cost is major consideration, otherwise use **Y** des = 0.

Table I-1 gives the relationship between the mainline design speed and the Ls and **Y** distances required for a 25 mph loop ramp design, in accordance with Exhibit G-2, with speed reductions at the approach nose of 12.5 and 35 percent, being the desirable and minimum designs respectively.

In order to produce an effective transition a minimum spiral length of 200 feet is required. Due to the inherent problems associated with excessive roll-over and the speed-curvature relationship of the spiral, both positive and negative **Y** values should not exceed 100 feet.

For the "special condition" involving negative **Y** values, as outlined in Chapter G, in conjunction with an assumed 35 percent speed reduction, such that a vehicle's speed differential between the approach nose and the controlling curvature is 10 mph or less, the exit spiral's C.S. point may result in being located upstream of the wedge point thus reducing the taper distance (B) below the values specified in Tables G-1 to G-4 inclusive. Provided the resultant B distance exceeds the minimum value, the roll-over factor is not exceeded and the negative **Y** value equals or is less than minus 100 the design is satisfactory. If either the roll-over factor and/or the maximum **Y** value specified are exceeded a smaller negative **Y** value must be utilized resulting in a subsequent increase in structure width.

Typical Loop Ramps

In order to combine the three major portions of any loop ramp design (exit terminal, controlling curvature and entrance terminal) the determination of their C.S. and S.C. or S.T. points is mainly one of trial and error. A suggested first approach in finding their approximate location is by the use of overlays or templates.

Having obtained this information the exact location and coordinates of all control points should then be calculated by computer or other means.

While the illustration of every loop ramp design was not considered feasible or warranted, the following examples serve to correlate the preceeding information and at the same time offer general guidance.

UAD 40 to UAD 40

Exhibit I-1 illustrates the "special condition", based upon a 35 percent speed reduction, for a loop ramp design between two arterial streets.

EXIT TERMINAL CONTROLS: As the controlling curvature (D_3) for loop ramps has been established at 38 degrees (25 mph) the assumed design speed at the approach nose equals 30 mph in accordance with the footnote of Table I-1, giving a speed differential of 5 mph and a **Y** value of minus 100 feet. Using a 200-foot minimum spiral the exit terminal geometry is developed on a separate template.

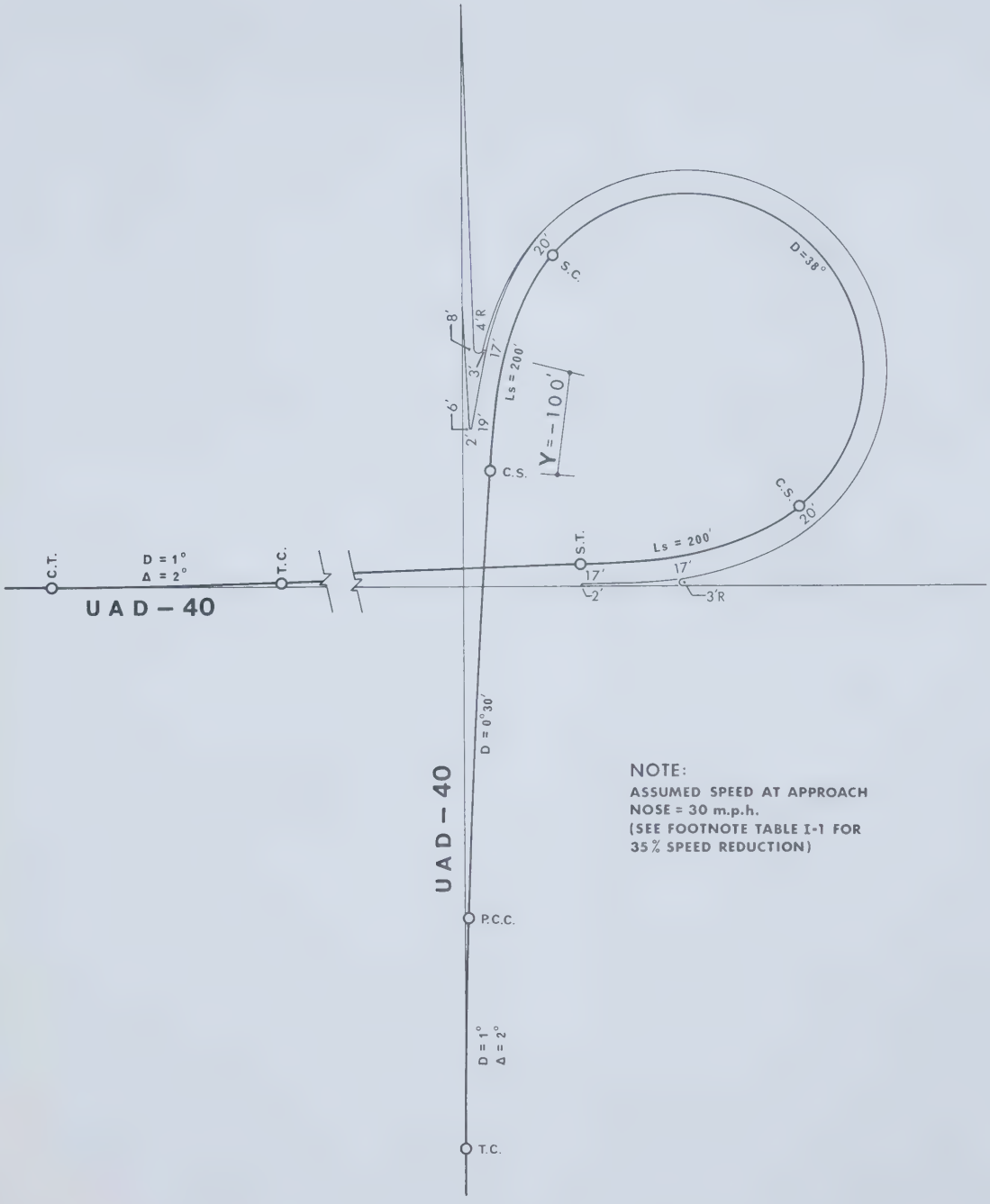
ENTRANCE TERMINAL CONTROLS: The entrance terminal geometry is likewise developed on another template using an Ls equal to 200 feet, D_3 of 38 degrees with Dc (from Exhibit H-1) of 1-degree.

Having developed the exit and entrance terminal criteria both overlays are superimposed simultaneously over the controlling curvature and inner edges of the mainline through pavements respectively and adjusted until a "fit" occurs, thus establishing the approximate C.S., S.C. or S.T. control points.

UFD 70 to UAD 40

Exhibits I-2 and I-3 compare typical loop ramp designs for vehicles exiting from a UFD 70 highway to a UAD 40 street bases upon exit speed reductions of 12 1/2 percent and 35 percent respectively. In the former case (12 1/2 percent) for the exit terminal design a spiral length of at least 390 feet, based upon the distance required to decelerate to the controlling curve speed, is indicated by Table G-5. Upon checking the **X** distance requirements the 40 mph control point is not satisfied, hence, a longer spiral length must be considered. A 500-foot spiral, although satisfactory, results in a **Y** distance in excess of +100 feet, therefore, a 600-foot spiral with a **Y** of +70, as indicated by Table I-1, is utilized. This geometry results in the approach nose being located in advance of the structure which is most desirable, when the major highway passes under the minor facility, in providing full-scale sign visibility. The entrance terminal design, for a controlling curvature of 25 mph, to a UAD 40 is similar to that of Exhibit I-1, hence, a 200-foot minimum spiral length was choosen. Shoulders are provided on both sides of the ramp, as a UFD highway is involved, with the right hand shoulder being transitioned and eliminated beyond the S.T. point of the entrance terminal.

In the case of the 35 percent speed reduction, an exit terminal spiral length of 300 feet results in a **Y** of zero with the C.S. occurring opposite the nose. This design, being the minimum acceptable, does not provide the driver with as much deceleration length as in the former case, and causes the approach nose to be located beyond the structure. Again for the entrance terminal, a standard tapered UAD 40 design with a 200-foot spiral is utilized.



NOTE:
ASSUMED SPEED AT APPROACH NOSE = 30 m.p.h.
(SEE FOOTNOTE TABLE I-1 FOR 35% SPEED REDUCTION)

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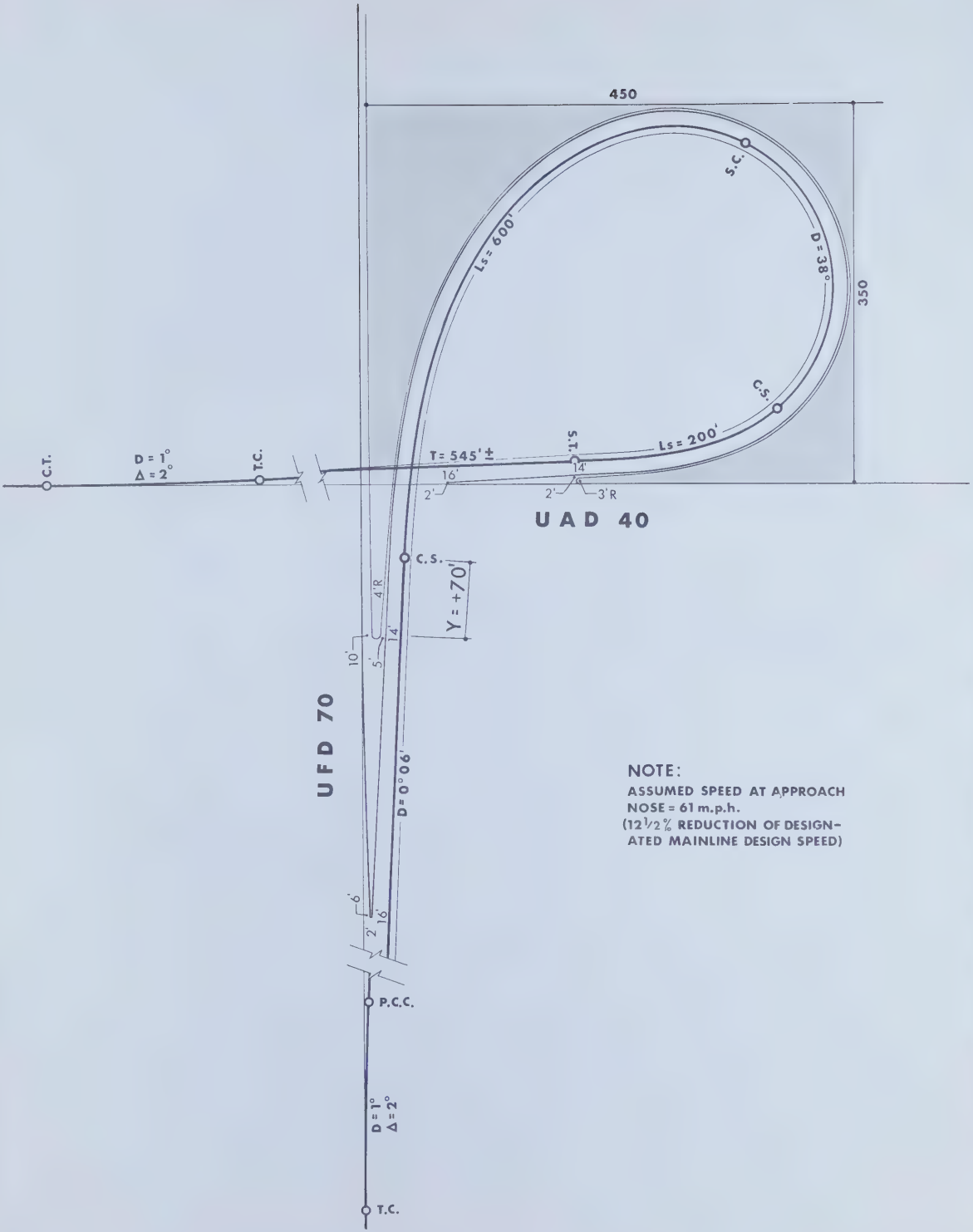
TYPICAL LOOP RAMP
UAD 40 - UAD 40

EXHIBIT I-2



NOTE:
ASSUMED SPEED AT APPROACH NOSE = 61 m.p.h.
(12½% REDUCTION OF DESIGNATED MAINLINE DESIGN SPEED)

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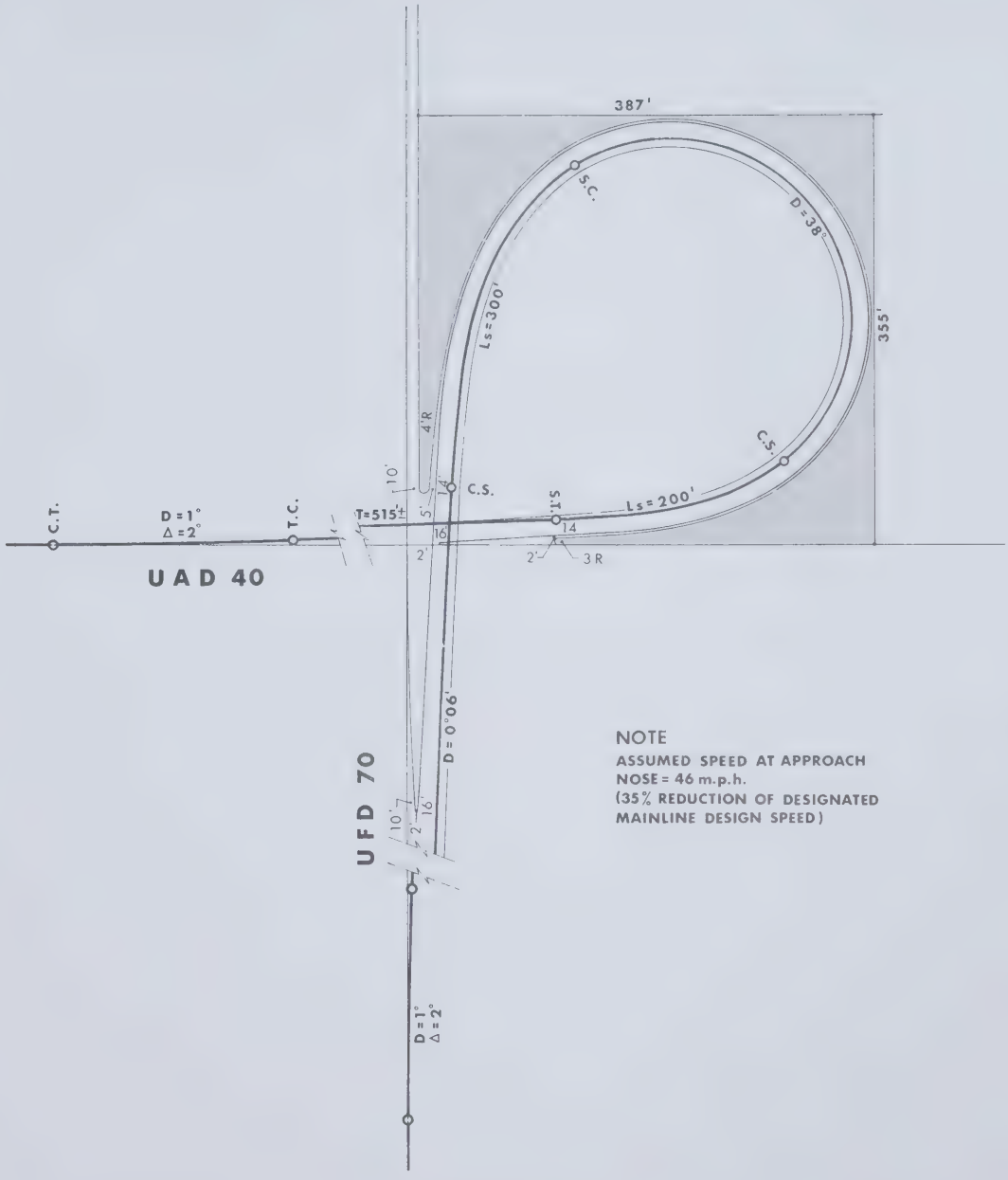
TYPICAL LOOP RAMP
UFD 70 - UAD 40



NOTE
ASSUMED SPEED AT APPROACH NOSE = 46 m.p.h.
(35% REDUCTION OF DESIGNATED MAINLINE DESIGN SPEED)

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URBAN HIGHWAY DESIGN GUIDE

TYPICAL LOOP RAMP
U F D 70 - U A D 40

PART 2

DRAFTING GUIDES FOR CONTRACT DRAWINGS

INTRODUCTION

The complexity of modern highway designs require engineering drawings to be clear, precise and uniform. In addition, they should be adaptable to microfilming and fractional scale reproduction. In order to achieve these goals it is essential that all drawings be of a similar format regardless of the agency producing the design.

The criteria presented herein provides the required guide lines to obtain the desired degree of uniformity. It is expected that the designer and/or draftsman will use discretion in the use of suggested procedures and materials, bearing in mind the desired end product.

Some benefits which can be expected to accrue from standardized drawings and drafting procedures are:

(A) Uniformity, enabling contractors to bid more accurately, resulting in lower contingency allowances and less cause for extra work claims as the contract progresses.

(B) Flexibility, providing the draftsman with greater scope in making additions and revisions to drawings.

(c) Efficiency, permitting engineers and administrative personnel to quickly process uniform plans and specifications.

Uniformity can be attained with a minimum of extra effort on the part of the designer and/or draftsman at little, if any, added cost.

The suggested standards have been compiled and developed from the practices of various highway authorities and private companies throughout Canada.

CHAPTER · J

GENERAL DRAFTING GUIDES

	Page
Pencil And Ink Work	J.1
Standard Sheets	J.1
Title Blocks	J.3
Scales	J.4
Lettering	J.4
Line Work	J.8
Shading	J.8

CHAPTER · J

GENERAL DRAFTING GUIDES

Pencil and Ink Work

To ensure consistency of quality and appearance throughout this Drafting Guide, each drawing example has been prepared using ink and mechanical lettering devices. In most instances, particularly when photographic reductions are to be considered, this method is recommended. However, the same plans may be prepared using pencil and if sufficient care is exercised, to maintain required line weights and lettering sizes, satisfactory results can be obtained.

The choice of using ink or pencil should be made after several factors have been considered; i.e., material to be worked on, purpose of the job, quality required, method of reproduction to be used, and capability of staff.

Standard Sheets

Standard size sheets recommended for original size work are 22 inches by 34 inches from trim edge to trim edge. The bordered, or working, area is 21 inches by 32 inches, leaving a binding edge on the left of 1 1/2 inches,and 1/2 inch borders on the remaining three edges. A half size reduction of the standard sheet can be accommodated on smaller printing presses.

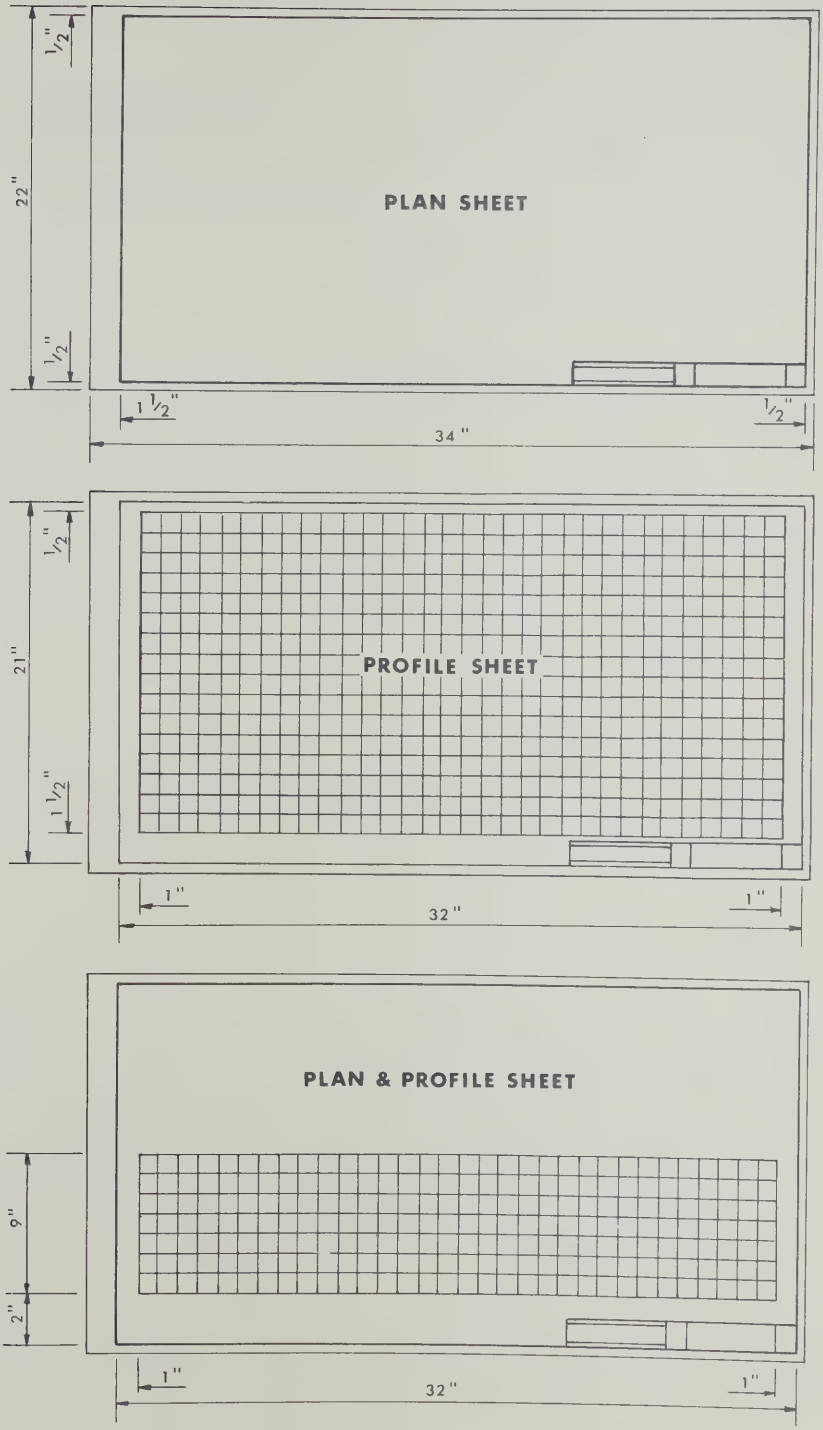

FIGURE J-1

NOTE:
BINDING EDGE IS 1 1/2" WITH A 1/2" BORDER ON THREE SIDES. ALL SHEETS ARE 34"x 22" TRIM EDGE TO TRIM EDGE.

Two basic types of contract drawing sheets, plan sheets and profile sheets, are shown by Figure J-1(A) and (B) respectively. These are sometimes combined on a single plan-profile sheet Figure J-1(C). Appropriate horizontal and vertical scales can be chosen to suit each situation.

Title Blocks

In order to conserve space on the drawings an abbreviated title block, as shown in Figure J-2(A), should be located in the lower right corner of each sheet. Additional information such as draftsmen and checkers initials, filing reference and approval, can be placed on the 1 1/2 inch binding edge of the sheet, as shown in Figure J-2(B). These are placed on master sheets before reproductions are made.

(A)

DESCRIPTION	DESIGN	DATE	CHK'D.	DATE	PLOT	DATE	CHK'D.	DATE

APPROVED DATE

(B)

FIGURE J-2

Scales

Most highway contract drawings require an indication of the drawing scale. For this purpose, a bar scale is recommended. Plans having a bar scale can be subjected to any size reduction while still maintaining the correct relation between scale indicator and plan details.

Lettering

Use of mechanical devices for lettering on all contract drawings will ensure a uniform appearance throughout, particularly if it is necessary for several draftsmen to work on the same contract. The lettering sizes discussed in this Guide refer to "K & E LEROY" or equivalent, and each size and line weight is shown to scale by Figure J-3(A). Reductions of these letter sizes by 50 and 75 percent are indicated in Figure J-3(B). Copies of these two figures on transparent material serve as useful tools for draftsmen in determining (a) letter sizes for each job and (b) the minimum letter size and line weight to be utilized, if reductions are planned.

The smallest lettering which can be reduced satisfactorily is made with template 80 using an 00 pen size; this lettering should be reserved for pavement elevation drawings and dimension descriptions on alignment control drawings only. If template 100 is used for these purposes, crowded conditions may result reducing clarity on pavement elevation drawings.

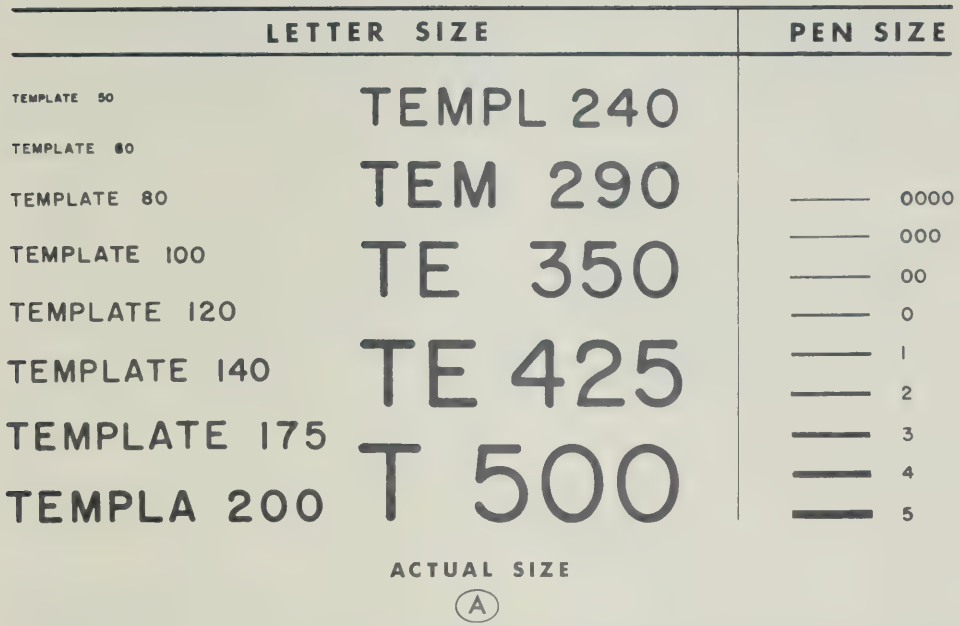
LETTER SIZE
PEN SIZE
TEMPLATE 50
TEMPL 240
TEMPLATE 60
TEMPLATE 80
TEM 290
TEMPLATE 100
TE 350
TEMPLATE 120
TEMPLATE 140
TE 425
TEMPLATE 175
T 500
TEMPLA 200
0000
000
00
0
1
2
3
4
5
ACTUAL SIZE
A
TEMPL 240
TEM 290
TE 350
TE 425
T 500
50% REDUCTION (1/2 SIZE)
TEMPL 240
TEM 290
TE 350
TE 425
T 500
75% REDUCTION (1/4 SIZE)
B

FIGURE J-3

When reductions of drawings are required, it is important to account for this factor in letter spacing. While legible at the original scale, closely spaced lettering becomes difficult to read at reduced scales and may even "bleed" together.

Slant lettering, achieved with an adjustable scriber, can often be used to advantage in creating a visual difference between new construction and existing detail. Existing features normally described by slant lettering are shown in Figure J-4.

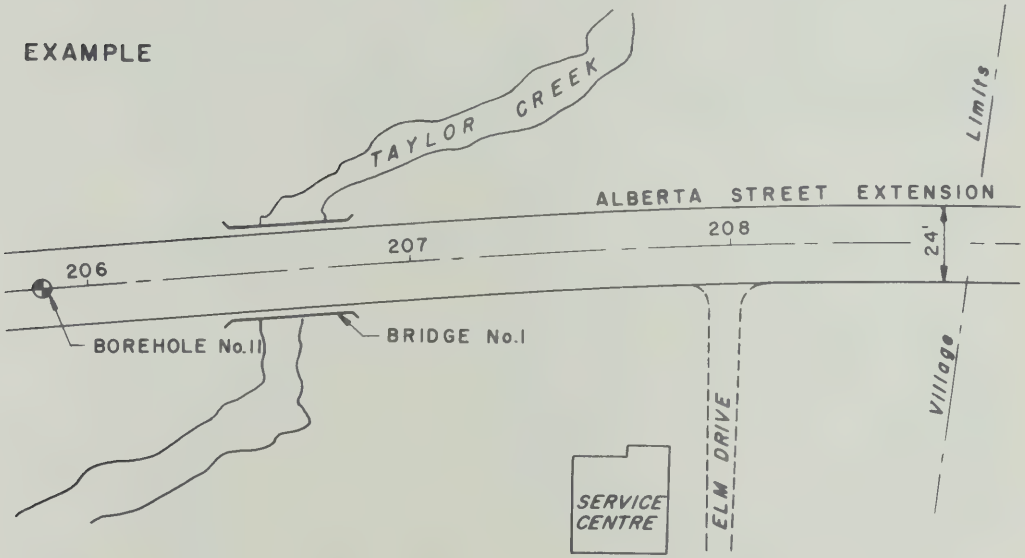

FIGURE J-4

Correct letter placement is indicated by Figure J-5(A). Topographic and highway drawings are intended to be read from the centre, hence, the direction of lettering should conform with the slope of symbol or line. Examples of correct and incorrect practices for orientation of lettering are shown on Figure J-5(B).

Lettering should be placed as close as possible to the detail or line, but should not touch the line.

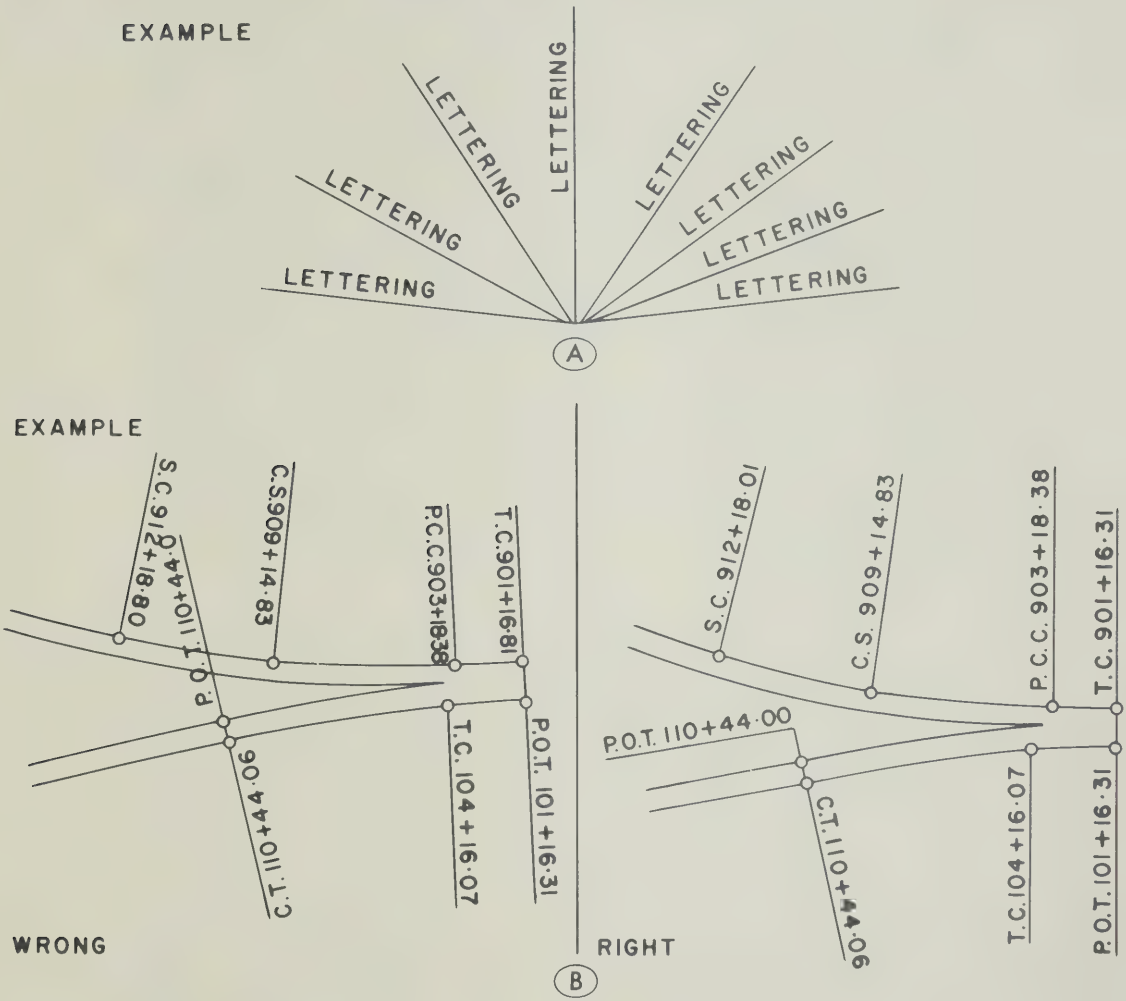

FIGURE J-5

Descriptive notes should be arranged in units of neat, block form. The lettering should parallel the bottom of the sheet when descriptions refer to details such as curb and gutter, streetlighting and guardrail. It should be parallel, or at

right angles, to the control line for alignment data, stationing, pavement elevations and other such information.

Line Work

A guide to line weights is illustrated by Figure J-6(A). Line weights less than 0.20 become very faint when reduced to half size, as indicated by Figure J-6(B). If reduced to 75 percent further loss is suffered. The 0.20 gauge is acceptable for dimension lines only; all line gauges below 0.20 are not to be employed when reductions of 50 percent or greater are required.

Care should be taken to ensure that parallel lines, when drawn closely together, be of the correct gauge. Certain situations may necessitate a reduction in line width, or spacing the

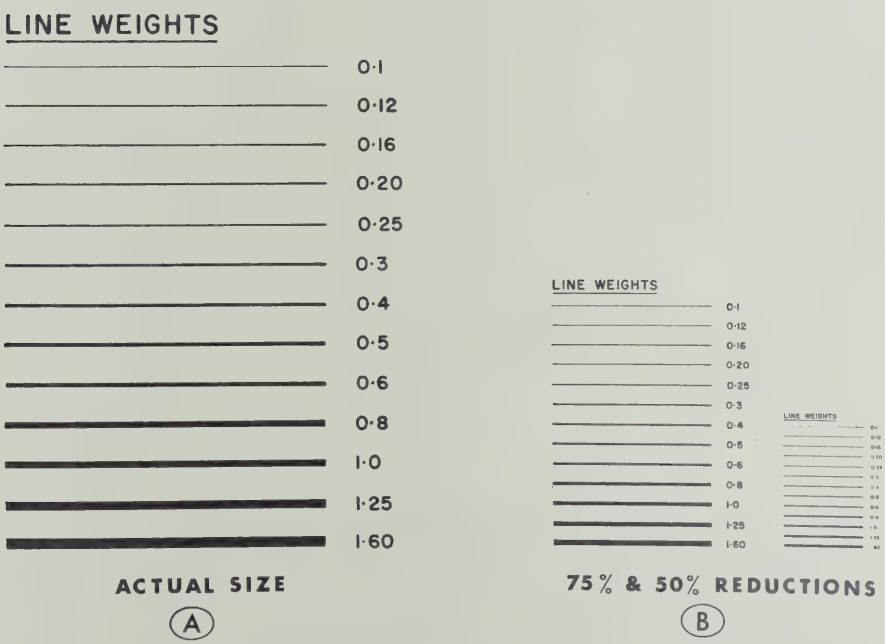

FIGURE J-6

lines further apart, so that the lines themselves do not bleed together when reduced. In most cases, the line spacing will be determined by dimension. However, some artistic license may have to be taken and the space widened even though it does not scale exactly.

Shading

Shading may be used on highway contract drawings to delineate asphalt type, sodding, removal of existing details, etc. For this purpose pressure sensitive heat resistant, or cut-and-stick-on material can be applied to either the front or back of drawings. Placing it on the back is the preferred method from the drafting point-of-view since further drafting detail can be added without difficulty. This procedure may create difficulties with the photographic reproduction process, therefore, this aspect should be checked before the material is applied.

The material application should be the last operation to complete a drawing. The use of coloured ink washes or pencil shading to indicate shaded areas should be avoided. Experience has shown that these methods do not reproduce satisfactorily when photographic reproductions or diazo process white prints are required.

CHAPTER · K

TYPICAL CONTRACT DRAWINGS

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Contract Drawings	K.3
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Alignment	K.7
-Control Drawings -Control Details	
Contract Masters	K.9
-Second Originals	
Grading & Paving	K.10
-Pavement Elevations -Grading & Pavement Legend -Grading & Pavement Details -Profiles -Typical Sections	
Drainage & Utilities	K.14
-Preparation of Drainage Drawings -Utilities Plan -Drainage Profiles	
Lighting	K.15

CHAPTER · K

EXHIBITS

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Grading and Paving	K-17,18,19,20,21
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Drainage Profiles	K-29,30
Lighting	K-31,32,33

CHAPTER · K

TYPICAL CONTRACT DRAWINGS

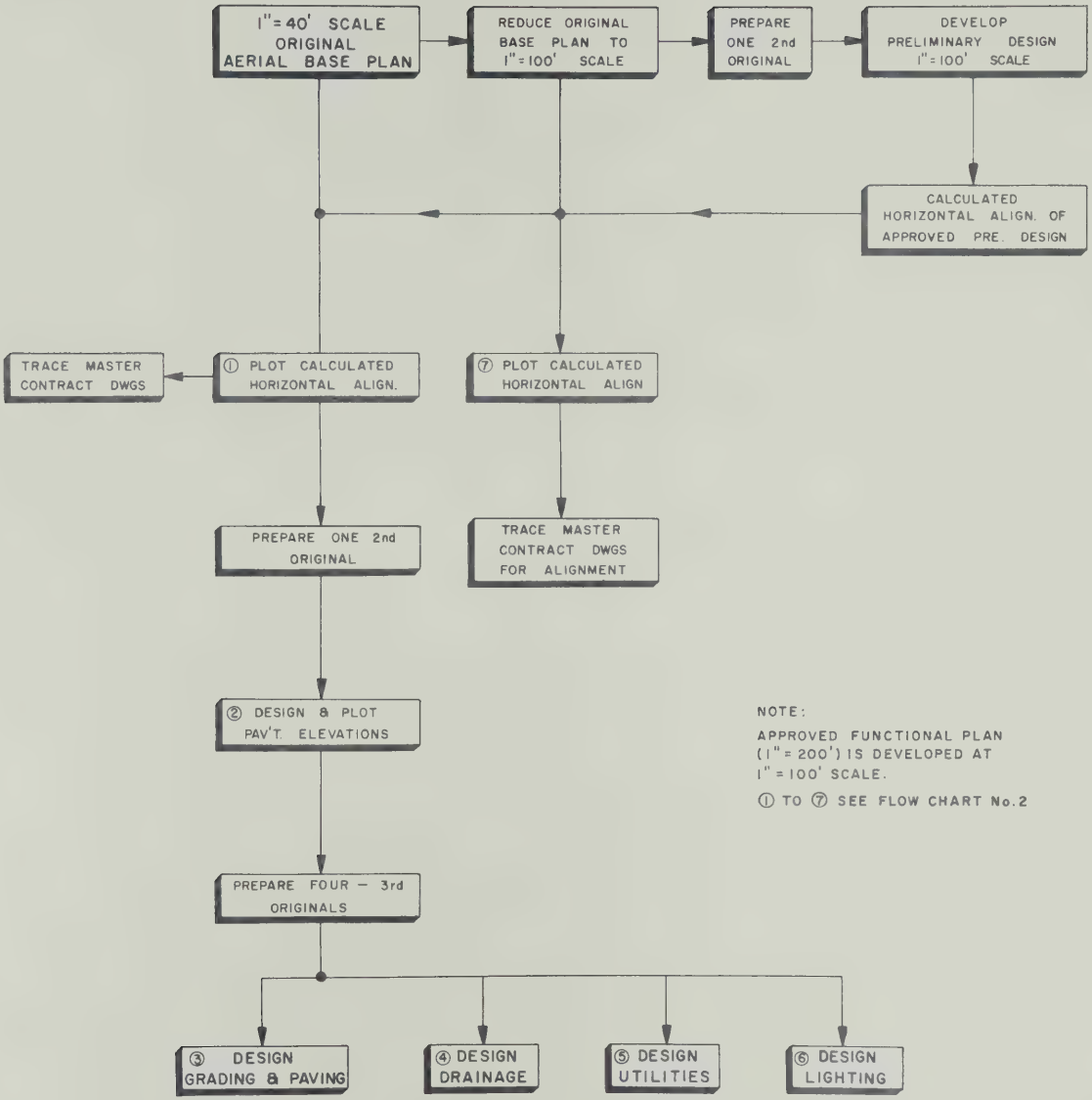
A suggested procedure for producing both design and contract drawings is outlined followed by specific information relating to letter sizes and line weights which are to be used on each drawing. Typical examples, in the order they would normally appear in contract documents, are included in this chapter.

Design & Contract Drawing Procedure

Design Drawings

A Design Flow Chart, Figure K-1, illustrates one method of proceeding to produce highway designs.

The horizontal alignment is first calculated and then plotted on topographic manuscripts at scales of 1 inch equals 100 feet and 1 inch equals 40 feet. The former plan is used primarily in calculating and checking the geometric design and to prepare the alignment drawings for contract. The 1 inch to 40 feet scale plot is used to trace a master contract drawing which is described in greater detail later in this chapter. After plotting the 1 inch equals 40 feet scale manuscript, a stable base film copy is taken and pavement elevations are superimposed onto this plan. Several stable base film copies of the pavement elevation design drawing are then taken to prepare the grading and paving, drainage, utility and lighting designs as per Figure K-1.


1"=40' SCALE ORIGINAL AERIAL BASE PLAN
REDUCE ORIGINAL BASE PLAN TO 1"=100' SCALE
PREPARE ONE 2nd ORIGINAL
DEVELOP PRELIMINARY DESIGN 1"=100' SCALE
CALCULATED HORIZONTAL ALIGN. OF APPROVED PRE. DESIGN
TRACE MASTER CONTRACT DWGS
① PLOT CALCULATED HORIZONTAL ALIGN.
⑦ PLOT CALCULATED HORIZONTAL ALIGN
PREPARE ONE 2nd ORIGINAL
TRACE MASTER CONTRACT DWGS FOR ALIGNMENT
② DESIGN & PLOT PAV'T. ELEVATIONS
NOTE:
APPROVED FUNCTIONAL PLAN (1"=200') IS DEVELOPED AT 1"=100' SCALE.
① TO ⑦ SEE FLOW CHART No.2
PREPARE FOUR — 3rd ORIGINALS
③ DESIGN GRADING & PAVING
④ DESIGN DRAINAGE
⑤ DESIGN UTILITIES
⑥ DESIGN LIGHTING

DESIGN FLOW CHART

FIGURE K-1

Contract Drawings

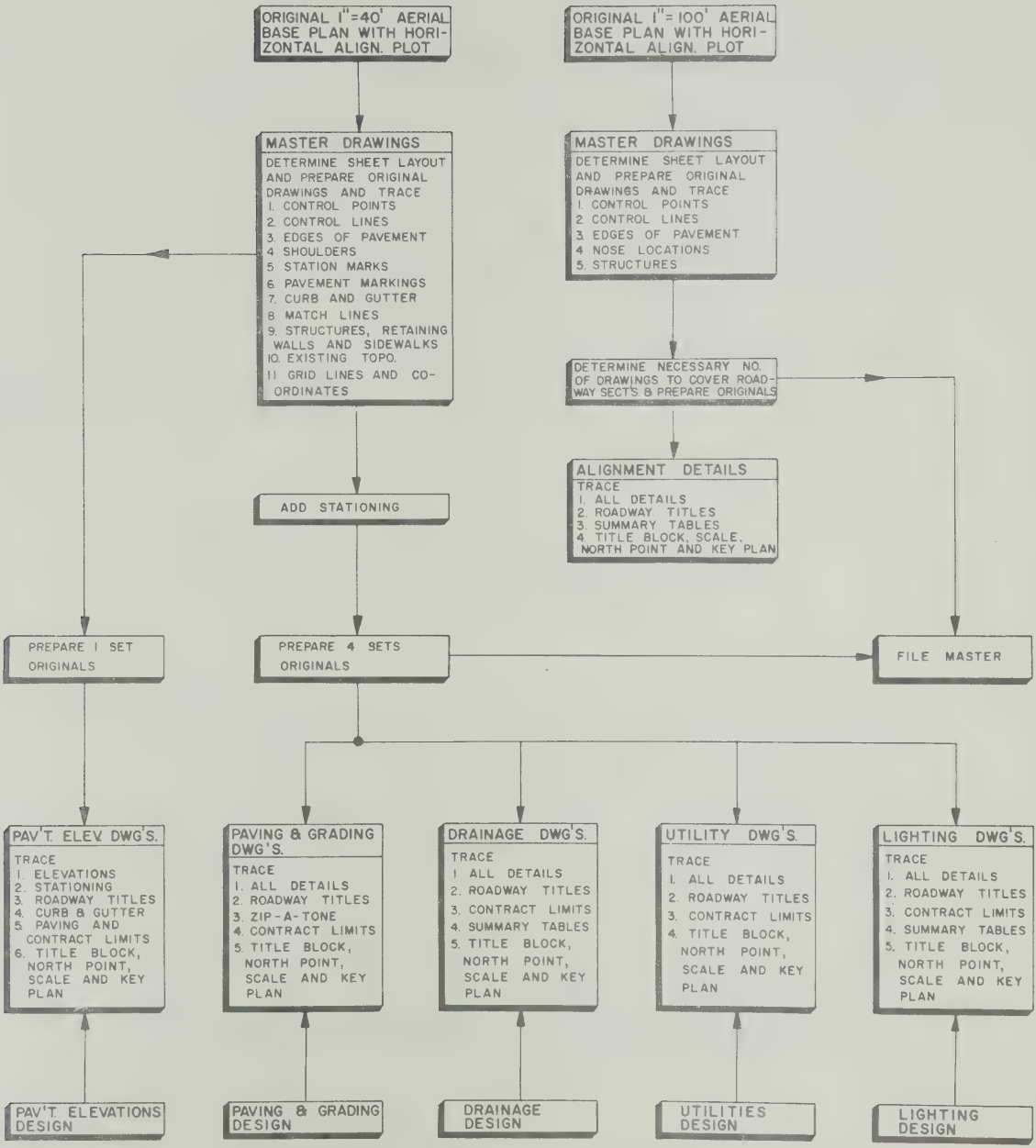
Both the design and contract drawing procedures indicated herein have been derived to complement each other. The suggested drafting procedure for producing contract drawings is shown on the Tracing Flow Chart, Figure K-2. The first step is the determination of a standard sheet layout upon which is traced the design information from the master design manuscripts at scales of 1 inch equals 100 feet and 1 inch equals 40 feet respectively.

In general, highway contract drawings are comprised of five main sections:

1. Alignment
2. Grading and Paving
3. Pavement Elevations
4. Drainage and Utilities
5. Lighting

The utilization of these major categories has the advantages of (a) preventing overcrowding of any particular drawing by permitting the numerous details, which must be shown, to be divided evenly and (b) allowing the distribution of contract drawing sets which are smaller and much easier for individual subcontractors to follow.

Alignment plans are drawn at a scale of 1 inch equals 100 feet, while all the remaining plan groupings are prepared at a scale of 1 inch equals 40 feet.



TRACING FLOW CHART

FIGURE K-2

Typical Contract Drawing Examples

The first exhibit for each example shows all information necessary to complete that particular drawing, while the second indicates the letter sizes and line weights required to produce the drawing itself. These examples also illustrate drawings which have been reduced to one-half their original size.

Cover Sheets

The outside cover sheet, Exhibit K-1, can be produced by means of mechanical lettering, or by using a transfer or pressure sensitive material. The inside cover or title sheet, Exhibit K-2, is produced in a similar manner. This sheet also includes a small scale key plan of the project.

Index Sheet

Typical index sheets are shown on Exhibits K-3 and K-4. It is recommended that a standard master index sheet be prepared. In this way the index sheet for each contract can be produced by making copies of the master sheet and filling in the appropriate information.

Key Plan

Key plans are used in three locations on contract drawings:

1. The key plan on the inside cover sheet, Exhibit K-2, illustrates the general location and outline of the project. Its main purpose is for orientation; i.e. relating the project to known land marks such as rivers, bridges

streets, etc. The plan scale is generally dependent upon the magnitude of the project, bearing in mind its relation to other components of the drawing. The scale may vary from 1 inch equals 2000 feet to 1 inch equals 10,000 feet.

2. The key plan of the project, Exhibit K-5, illustrates the contract limits and is normally contained on a separate drawing located immediately following the index sheet. If possible, the entire project should be shown on one sheet at a scale of 1 inch equals 200 feet. Information shown on this plan should include contract limits, all structures, identification of all roads and ramps, and geographic features such as lakes, rivers, railways, etc.

3. Key plan inserts are included on the alignment layout drawings, Exhibits K-11 and K-12, and contract master drawings, Exhibits K-13 and K-14. From the contract masters they are reproduced on the drawings of all other sections. The key plan inserts serve the purpose of relating the location of each drawing to the total project. If possible, it should be located in the same position on all drawings perferably in, or near, the top right corner. The area which the particular drawing covers should be blocked out on the key plan, as indicated. A preprinted stick-on process can be used for the preparation and placement of the key plan inserts.

Construction Staging

Maintenance of traffic is often the critical factor in determining a projects construction staging. Exhibits K-7 and K-8 are typical illustrations of a construction stage drawing. Each successive major stage of construction, in which a new routing of traffic is necessary, will require a separate staging plan.

Preparation of Stage Drawings

1. Prepare a master drawing of all existing roads, leaving sufficient space for summary blocks. Label all roadways, station changes, etc. In some instances the key insert, Exhibit K-5, can be used to develop this plan.
2. Make a second original of the master for filing reference.
3. Using a step-by-step procedure, add the line work of the new roadway, detours and retaining walls, covered by the construction of Stage 1, to the master drawing.
4. Make another second original and place the appropriate shaded delineators, as defined by a legend, on this drawing. This sheet is now the original for Stage 1.
5. Using the master drawing as in step 3, add the line work and any deletions necessary for Stage 2.
6. Again make a second original and proceed as in step 4 to produce the original for Stage 2.
7. Repeat the process as per step 5 for as many separate construction stages as required. When all sheets are complete, add summary blocks and descriptions of each stage.
8. Complete each sheet with a title, and cross-references where necessary.

Alignment

Control Drawings

Alignment control drawings, Exhibits K-9 and K-10, provide basic horizontal control for the project. Ties to key monuments are shown along with the main base line survey used for development

of the design and construction drawings. The method of showing control points and ties is as follows:

1. Basic survey control lines are drawn in single line form, and preferably all on a single sheet.
2. Description of all hubs, tangents, points of intersection, and chainage equations are noted.
3. Chainages are shown to two decimal places, and azimuths in degrees, minutes and seconds.
4. Enlarged tie details are arranged in an orderly fashion as near as possible to the points on the control line, to which they pertain.
5. Co-ordinates for each survey bar or monument are shown.

Control Details

Alignment layout drawings, Exhibits K-11 and K-12, are produced at a scale of 1 inch equals 100 feet. All horizontal alignment details necessary for complete on-site layout of the project are included on these plans. Co-ordinates of all main points on the alignment are shown, as well as all simple and spiral curve data. The recommended procedure for development of alignment layout drawings is as follows:

1. Divide the contract into sections, of a logical sequence, for preparation at a scale of 1 inch equals 100 feet.
2. Prepare master plans for each section showing pavement edges, control lines and reference points. Omit points of intersection (P.I.'s) on control lines to prevent overcrowding.
3. Divide the control lines for each section into groups, and make as many second originals of each master plan as necessary for the remaining steps.

4. On each second original, use a 0.6 gaugeline to increase the line weight of all control lines, containing control information, to be shown on that particular drawing (see Exhibit K-11).

5. Describe control points to two places of decimals. Show azimuths and ties at the beginning and end of each line. (For example: Ramp E-N of Exhibit K-11, the azimuth at the beginning of the ramp is 177 degrees-00 minutes and at the end of the ramp it is 82 degrees-30 minutes).

6. Identify each tangent and curve in the order of increasing chainage and title each roadway. (For example, each ramp is labelled according to the direction of traffic. Ramp E-N means traffic is from the east and is going north. Referring to Ramp E-N on Exhibit K-11, the curves and spirals are numbered for handy reference in the tables. Number 101 is a spiral, 102 a curve, 103 a spiral, 104 a curve and so on. Each ramp is also given a particular 100 series for easy identification. Ramp E-N is 101, 102, etc. Ramp N-E is 201, 202, etc.)

7. All information necessary for field layout, such as curve and spiral data, co-ordinate information, chainage, etc., is to be tabulated and shown in table form on each alignment drawing.

Contract Masters

The 1 inch to 40 feet scale master contract drawings, referred to on page K.1, are drawn in units of approximately 1,000 feet of control line chainage whenever possible, with the centre line of roadway parallel to the bottom edge of the sheet. Special care must be taken to ensure that the drawing is located on the sheet in such a manner as to leave sufficient space for the key plan insert and various summary tables, required for the drainage and

lighting portions of the contract. Chainage for the project should increase from West to East and from South to North. Therefore, each roadway section is oriented so that the North arrow is pointing toward the top or right of the drawing sheet.

Contract masters, such as Exhibit K.13, are traced directly from the original 1 inch to 40 feet scale alignment design plot. Although this exhibit has chainages indicated, in the normal procedure these are not added until a first set of originals have been made for the preparation of pavement elevation drawings. Experience has shown that reproductions of originals with stationing placed on the roadway, required for the other design drawings, will conflict with the pavement elevations.

Second Originals

Reproductions made from the contract master drawings for the various divisions of design are usually referred to as second originals. They are normally produced using the diazo system on a stable film or sepia material. If the second originals are made so as to be "reverse reading", the original line work will be on the back of the material. All new design information can then be placed on the clear, front face of the drawing.

All divisions of the contract, with the exception of the pavement elevation drawings, will have second original base plans which are exactly the same for each. Visual repetition is thus created which will aid in locating the various phases of design.

Grading and Paving

Pavement Elevations

A typical pavement elevation drawing is illustrated by Exhibit K-15. Such a plan is produced, using a scale of 1 inch to 40 feet for

vertical control and project layout, in the following manner:

1. Use a reverse reading second original reproduction of the master drawing for each section. As reproductions for the pavement elevation drawings are taken before the stations are applied to the master drawings the chainages will not be in the way of the pavement elevations.

2. Draw all new work on the front of the drawing.

3. Indicate all structures and retaining walls if not already shown on the master.

4. Plot station marks and pavement elevations every 50 feet across the full width of the pavement and shoulder except at the following locations.

   a. all ramps
   b. all exit and entrance terminals
   c. all at-grade intersections
   d. transitions of superelevations on major roadways and other areas where considered necessary

   At locations (a) to (d) inclusive elevations are shown every 25 feet to ensure smooth profiles throughout critical areas.

5. Where shoulder crowns are required, indicate the crown with short, dashed lines and show elevations every 25 or 50 feet. Pavement elevations are to be shown to two decimal places. In order to save repetition, the hundred digit may be left off, except at the beginning and end of each sheet and also where the elevation changes to the next hundredth. Leaving the 100th digit off helps to clarify the drawing as it tends to crowd space too much when placed at 25-foot intervals.

6. When possible, show 100-foot stationing outside roadways so as not to interfere with elevations.

7. Indicate curb and gutter by a heavy line adjacent to the outer pavement edge. In some cases, different types of

curbs and gutters may be used and these types can be shown on the drawing. Transitions may also be indicated if so required.

8. Complete the drawing with roadway titles, north point, scale, title block and key plan.

Grading & Pavement Legend

The grading and pavement legend should be shown on a separate plan, as indicated by Exhibit K-17. All lines, symbols, and shadings used on the grading and pavement details, Exhibit K-18 to K-21, are identified on this sheet.

Grading & Pavement Details

General details illustrated include earth grading design, surface drainage, guardrail, sign footings, fencing, pavement types and pavement dimensions. Two methods of depicting earth grading may be used, either the contour method of Exhibit K-18 or the slope line method of Exhibit K-20. Even though the slope line method is acceptable and quite widely used, the contour method has the following distinct advantages:

1. It provides the contractor with positive guidance for shaping roadway slopes in the manner intended by the designer.
2. It helps in blending structures, side slopes and other surface features with the surrounding terrain, into an integrated, aesthetically pleasing entity.
3. It assists the landscape designer in co-ordinating his design with the overall objective of the project.

The drafting procedure for producing grading and paving details is outlined as follows:

1. Use a reverse reading second original reproduction of the master drawing for each section.

2. Draw all new work on the front.

3. Indicate all structures and retaining walls not already shown on the masters.

4. Show new contours every two feet and accentuate every 10-foot contour. Use slant letters for the datum. Show existing contours in short, dashed lines. When slope lines are used indicate as shown on Exhibit K-20.

5. Show all ditches and indicate direction of flow. If special ditches are required a small typical detail, not to scale, may be shown on the drawings. Flow changes at high and low points should be indicated by a short perpendicular line.

6. Indicate all fences, right-of-way lines and easements complete with descriptions.

7. Locate all guardrails and sign footings.

8. Detail all pavement and offset dimensions for approach noses, merging ends and tapers. All offset and width dimensions are to be shown to two decimal places.

9. Add all miscellaneous details, titles and directional arrows to each of the roadways. Complete the drawings with pressure sensitive or stick-on material for all sodding, rip-rap paving delineations, north point, key plan scales, etc. Note: When delineating asphalt and pavement type at structures, the roadways at the higher elevations usually take precedent.

Profiles

Profile drawings are included in contract documents as a supplement to the pavement elevation drawings. Their main function is to provide a general concept of the location and extent of the various cut and fill sections along the project. Although the information indicated on Exhibit K-22 may be adjusted

to suit the particular conditions of any contract, items normally shown include the existing ground at the control line location, the final control line elevation with grade percentages noted and notes describing location and elevation of nearby bench marks.

Typical Sections

Exhibits K-24 and K-25 illustrate typical cross-sectional elements at various locations along the project. The information and dimensions on these drawings may vary according to local conditions.

Drainage and Utilities

Drainage and utility details may be contained on the same drawing if the amount of information required to be shown does not unduly crowd the plan as indicated by Exhibits K-27 and K-28. There will be many cases where it is advisable to separate the two items. All symbols used on these plans are indicated by a drainage and utility legend, Exhibit K-26, prepared as a separate sheet.

Preparation of Drainage Drawings

1. Use a reverse-reading second original reproduction of the master drawing for each section.
2. Draw new work on the front and remove any base line work on the back when it interferes.
3. Indicate all structures and add any retaining walls not shown on the master.
4. Locate all catch basins.
5. Indicate all existing sewers, culverts and describe where necessary using slanted letters.

6. Include on the same drawing all information for catch basins and pipes. However, if extensive summary data is required, it can be included on a separate sheet and cross-referenced.

Utilities Plan

Utility plans are prepared in a manner similar to the drainage drawings using utility symbols in accordance with the utility legend of Exhibit K-26.

Drainage Profiles

Typical storm sewer profiles are shown on Exhibit K-29. The scales of these profiles can be varied to meet the requirements of each individual contract. In general, on highway contracts, only trunk sewer profiles are shown, while pertinent information for laterals is depicted on the summary blocks of the individual contract drawings. Repetitive descriptions of stations, classes of pipes, cover types and elevations can be avoided in this way.

Lighting

Lighting drawings, indicated by Exhibits K-32 and K-33, are also prepared on reverse reading second originals of the master drawings, with all lighting design placed on the front face of each sheet. A legend explaining the symbols used on these drawings, as shown by Exhibit K-31, is prepared on a separate sheet.

EXHIBIT K-1

THE CITY OF EDMONTON

CONTRACT DRAWINGS
FOR

MAYFAIR INTERCHANGE

CONTRACT Nº 351

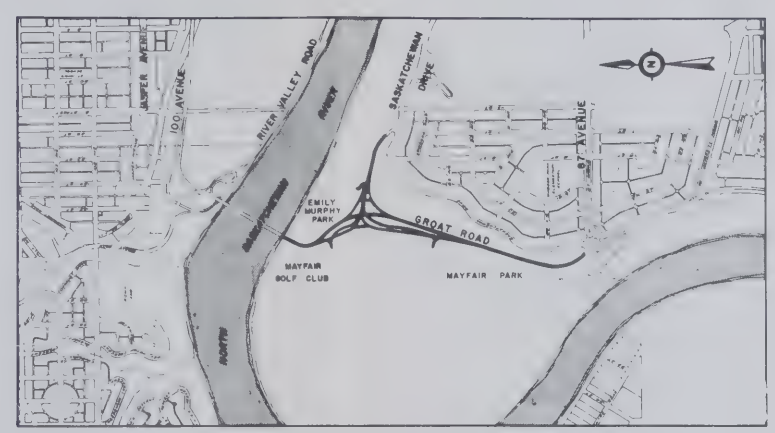
TYPICAL

THIS SHEET PRODUCED
BY USING PRESSURE
SENSITIVE LETTERS.

EXHIBIT K-2

THE CITY OF EDMONTON

CONSULTANTS NAME



KEY PLAN

0 1000 2000 3000

THE CITY OF EDMONTON

CITY ENGINEER

MAYFAIR INTERCHANGE

CONTRACT Nº 351

TYPICAL

THIS SHEET PRODUCED BY USING PRESSURE SENSITIVE LETTERS.

EXHIBIT K-3

ORIGINAL SHEET Nº	DESCRIPTION	REVISED SHEET Nº
R 1	TITLE SHEET	
R 2	INDEX	
R 3	INDEX	
R 4	KEY PLAN	
	CONSTRUCTION STAGING	
R 5	STAGE I	
R 6	STAGE II	
R 7	STAGE III	
R 8	STAGE IV	
R 9	STAGE V	
R10	STAGE VI	
	ALIGNMENT DETAILS	
R11	ALIGNMENT CONTROL & TIES	
R12	℄ GROAT ROAD, RAMP N-E, EMILY MURPHY EASTBOUND AND	
	EMILY MURPHY WESTBOUND	
R13	EMILY MURPHY PARK RAMP, RAMP EW-N, RAMP W-N & RAMP E(CLUB)W	
R14	℄ GROAT ROAD, RAMP S-EW, RAMP S-E & RAMP E-S	
R15	RAMP W(PARK)E, RAMP E(PARK)W, RAMP W(PARK)S, RAMP N-S	
	GRADING AND PAVEMENT DETAILS	
R16	LEGEND	
R17	STA. 183+00 TO LIMIT OF CONTRACT	
R18	STA. 172+00 TO STA. 183+00	
R19	STA. 160+50 TO STA. 172+00	
R20	STA. 149+10.26 TO STA. 160+50	
R21	LIMIT OF WIDENING TO STA. 248+80.84	
R22	EMILY MURPHY EASTBOUND AND WESTBOUND	
	OVERHEAD SIGNING	
R23	OVERHEAD SIGN STRUCTURES	
R24	SIGN STRUCTURE DETAILS	
	PAVEMENT ELEVATIONS	
R25	STA 183+00 TO LIMIT OF CONTRACT	
R26	STA. 172+00 TO STA. 183+00	
R27	STA. 160+50 TO STA. 172+00	
R28	STA. 149+10.26 TO STA. 160+50	
R29	LIMIT OF WIDENING TO STA. 248+80.84	
R30	EMILY MURPHY EASTBOUND AND WESTBOUND	

ORIGINAL SHEET Nº	DESCRIPTION	REVISED SHEET Nº
	PAVEMENT PROFILES	
R31	GROAT ROAD NORTHBOUND AND SOUTHBOUND	
R32	GROAT ROAD SOUTH END, EMILY MURPHY PARK RAMP	
R33	EMILY MURPHY WESTBOUND, RAMP E(CLUB)W, RAMP E-S	
R34	RAMP N-E, EMILY MURPHY EASTBOUND, RAMP S-E, RAMP S-EW	
R35	RAMP W(PARK)E, RAMP E(PARK)W, RAMP N-S	
R36	RAMP W(PARK)S, RAMP EW-N, RAMP W-N	
	TYPICAL SECTIONS	
R37	KEY PLAN	
R38	GROAT ROAD IN VICINITY OF STA. 153+00 & STA. 169+00	
R39	GROAT ROAD IN VICINITY OF STA. 177+00	
R40	GROAT ROAD IN VICINITY OF STA. 181+00	
R41	EMILY MURPHY E.B. & W.B., MAYFAIR PARK ENTRANCE	
	STANDARD DETAILS	
R42	GUARDRAIL, SINGLE BEAM AND DOUBLE BEAM	
	CONCRETE STEPS	
R43	CURB RETURN R=2'	
	CURB RETURN R=3'	
R44	TYPICAL CURB AND GUTTER, TYPE I AND TYPE II	
	TYPICAL SIDEWALK	
	GUARDRAIL CONNECTION TO STRUCTURE	
R45	SIGN POST STRUCTURE ON MEDIAN OF EMILY MURPHY	
	MONOLITHIC CURB AND GUTTER MEDIAN	
	CHAIN LINK FENCE	
	CONCRETE SLAB ISLAND	
R46	GUARDRAIL TAPER AND ANCHORAGE	
	DRAINAGE AND UTILITIES	
R47	LEGEND	
R48	STA. 183+00 TO LIMIT OF CONTRACT	
R49	STA. 172+00 TO STA. 183+00	
R50	STA. 160+50 TO STA 172+00	
R51	STA 149+10.26 TO STA 160+50	
R52	LIMIT OF WIDENING TO STA. 248+80.84	
R53	EMILY MURPHY EASTBOUND AND WESTBOUND	
	DRAINAGE DETAILS	
R54	BRIDGE DRAIN UNDER PIER FOOTINGS	
	CATCHBASIN CONNECTION TO EXISTING CATCHBASIN CONNECTION	
	MANHOLE TYPE "A"	
	MANHOLE TYPE "B"	

TYPICAL

LAST REVISION DATE: _____ 19____

NEW REVISION DATE: _____ ____

INDEX

SHEET

EXHIBIT K-4

140 TEM. 1-PEN

240 TEM. 3-PEN

175 TEM. 2-PEN

BOARDERS 0·8 LINE GAUGE

DIVISIONS 0·4 LINE GAUGE

DESCRIPTIONS
175 TEM. 2-PEN

MAIN TITLES
200 TEM. 3-PEN

200 TEM. 3-PEN

CONSTRUCTION STAGING

STAGE I

STAGE II

STAGE III

STAGE IV

STAGE V

ALIGNMENT DETAILS

ALIGNMENT CONTROL @ TBS

R 32 | R GREAT RD., RAMP N-E, EMILY MURPHY EASTBOUND AND EMILY MURPHY WESTBOUND

R 33 | EMILY MURPHY PARK HOME RAMP, RAMP EW-N, RAMP W-N & RAMP E(C.U.)W

R 34 | R GREAT RD., RAMP E-S, RAMP S-E & RAMP E-S

RAMP W-(PARK)E, RAMP E(PARK)W, RAMP N-S, RAMP W(PARK)S, RAMP EW-N, RAMP W-N

GRADING AND PAVEMENT DETAILS

R 48 | FROM

STA 181+00 TO LIMIT OF CONTRACT

STA 172+00 TO STA 183+00

STA 160+50 TO STA 172+00

STA 149+10.26 TO STA 160+50

LIMIT OF WIDENING TO STA 248+80.84

EMILY MURPHY EASTBOUND AND WESTBOUND

OVERHEAD SIGNING

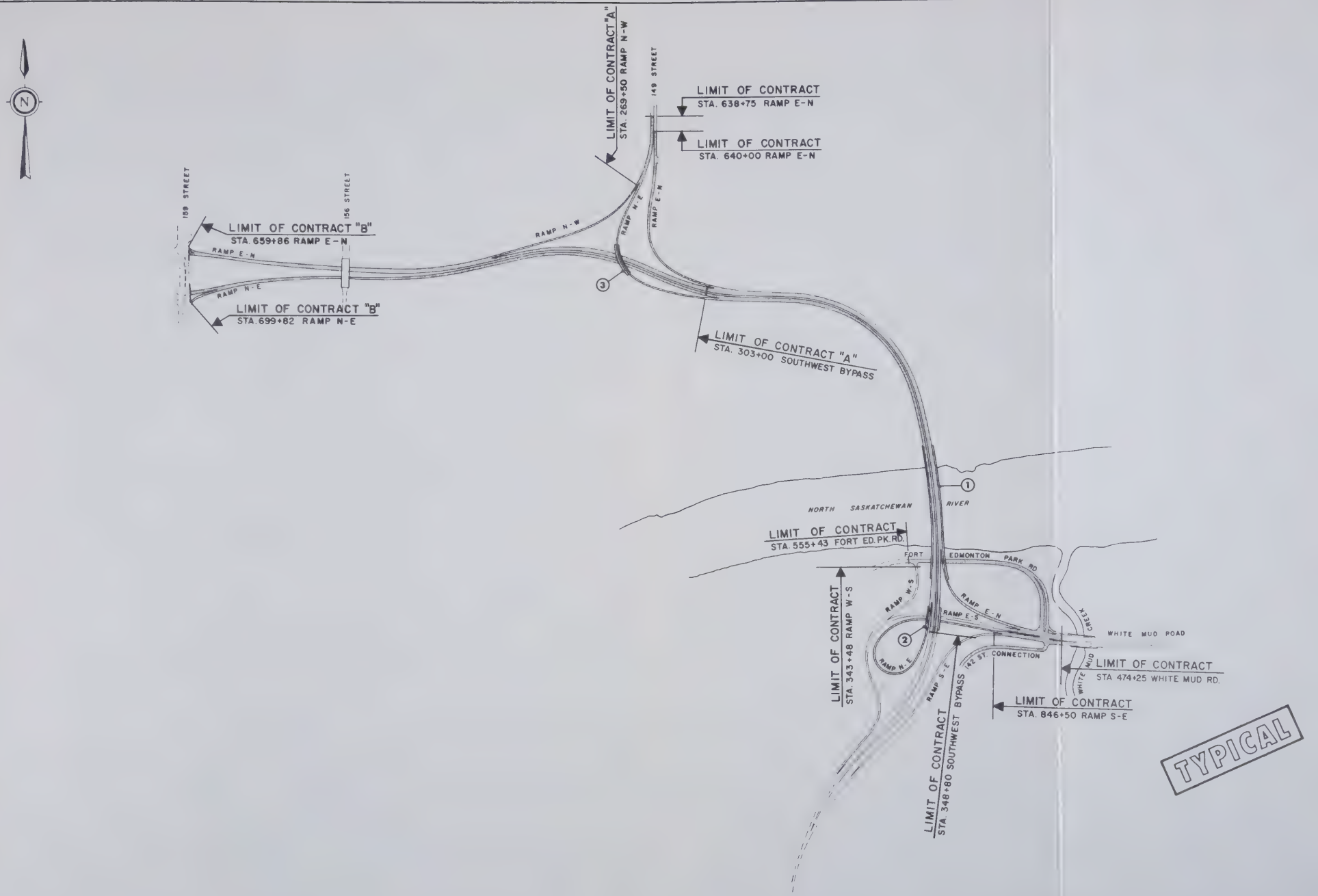
STA 160+50 TO STA 172+00

STA 149+10.26 TO STA 160+50

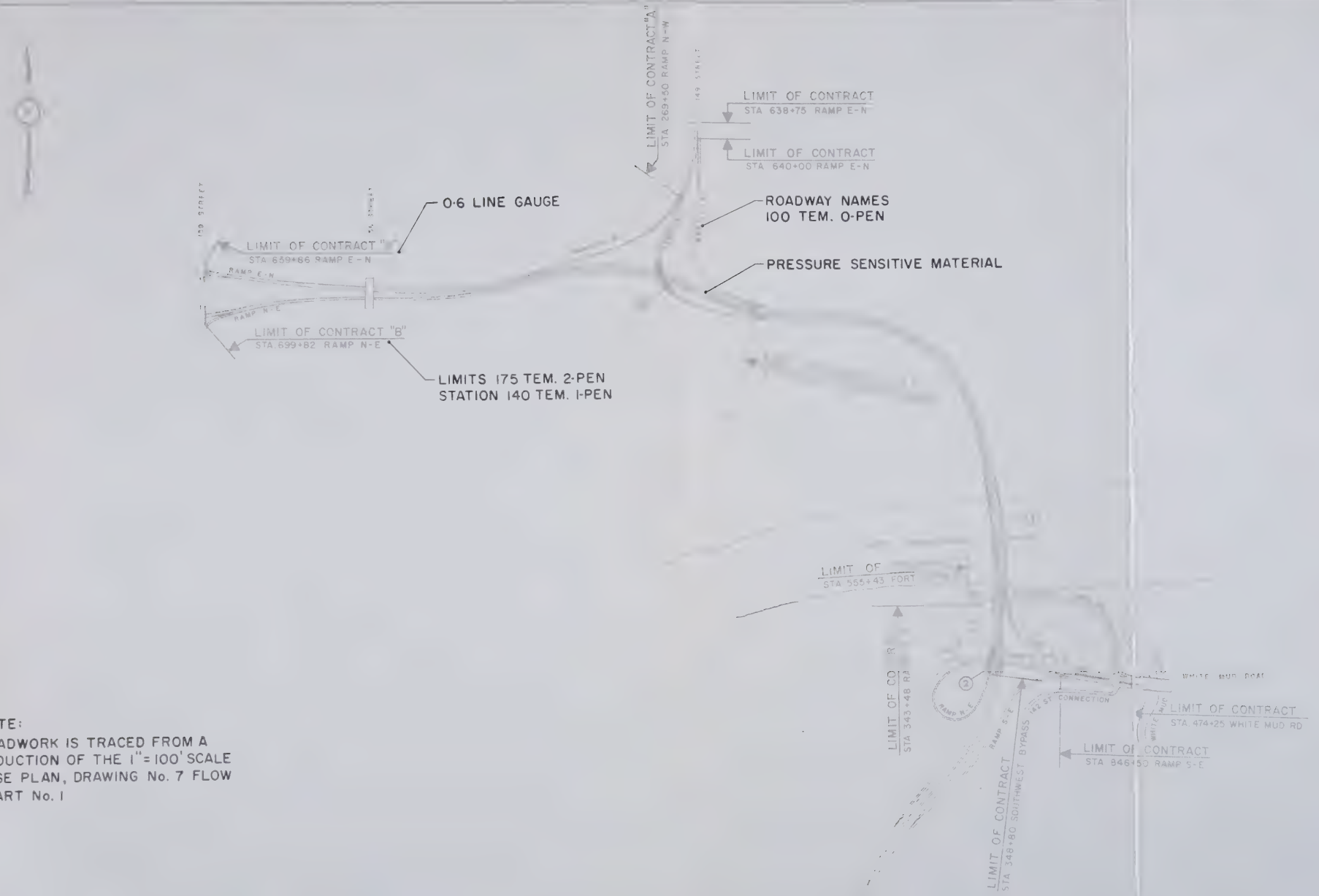
NEW

ORIGINAL SHEET NO.	DESCRIPTION
	PAVEMENT PROFILES
R 31	GROAT ROAD NORTHBOUND AND SOUTHBOUND
R 32	EMILY MURPHY EASTBOUND, RAMP E-S, RAMP N-E, EMILY MURPHY EASTBOUND, RAMP
R 35	RAMP W(PARK)E, RAMP E(PARK)W, RAMP N-S
R 36	RAMP W(PARK)S, RAMP EW-N, RAMP W-N
	TYPICAL SECTIONS
R 37	KEY PLAN
R 38	GROAT ROAD IN VICINITY OF STA 153+00 & STA 169+00
R 39	GROAT ROAD IN VICINITY OF STA 177+00
R 40	GROAT ROAD IN VICINITY OF STA 181+00
R 41	EMILY MURPHY E.B. & W.B., MAYFAIR PARK ENTRANCE
	STANDARD DETAILS
R 42	GUARDRAIL, SINGLE BEAM AND DOUBLE BEAM
	CONCRETE STEPS
R 43	CURB RETURN R=2'
	CURB RETURN R=3'
R 44	TYPICAL CURB AND GUTTER, TYPE I AND TYPE II
	TYPICAL SIDEWALK
	GUARDRAIL CONNECTION TO STRUCTURE
R 45	SIGN POST STRUCTURE ON MEDIAN OF EMILY MURPHY
	MONOLITHIC CURB AND GUTTER REMOVAL
	DRAINAGE AND UTILITIES
R 49	STA 172+00 TO STA 183+00
R 50	STA 160+50 TO STA 172+00
R 51	STA 149+10.26 TO STA 160+50
R 52	LIMIT OF WIDENING TO STA 248+80.84
R 53	EMILY MURPHY EASTBOUND AND WESTBOUND
R 54	BRIDGE DRAIN UNDER PIER FOOTINGS
	CATCHBASIN CONNECTION TO EXISTING CATCHBASIN CONNECTION
	MANHOLE TYPE "A"

EXHIBIT K-5



CITY OF EDMONTON			SHEET
SOUTH WEST BYPASS STAGE 1		KEY PLAN	



NOTE:
ROADWORK IS TRACED FROM A REDUCTION OF THE 1"=100' SCALE BASE PLAN, DRAWING No. 7 FLOW CHART No. 1

CITY OF EDMONTON
SOUTH WEST BYPASS
STAGE 1

EXHIBIT K-7

STAGE IV

TRAFFIC

1. GROAT ROAD NORTHBOUND & SOUTHBOUND TRAFFIC CHANNELIZED INTO TWO WESTERLY LANES FROM STA. 165+00 SOUTH.
2. CHANNELIZE GROAT ROAD, NORTHBOUND INTO WESTERLY LANE AND SOUTHBOUND INTO THE EASTERLY LANE OF DETOUR D1 BETWEEN GROAT BRIDGE AND STA. 165+00.
3. ACCESS TO EMILY MURPHY PARK IS DISCONTINUED FROM THE WEST, ACCESS TO EMILY MURPHY PARK IS MAINTAINED FROM THE EAST WHILE THE WEST PART OF THE STAGE IS BEING COMPLETED.

CONSTRUCTION

I PROVIDE ACCOMMODATIONS FOR TWO WAY TRAFFIC ON NORTHBOUND LANES OF GROAT ROAD UNDER OVERPASS.

II CONSTRUCT GROAT ROAD NORTHBOUND FROM OVERPASS NORTH TO APPROXIMATELY STA. 187+00, AND SOUTHBOUND FROM STA. 183+00 TO STA. 187+00.

3. CONSTRUCT GROAT ROAD NORTHBOUND FROM STA. 168+00 TO SOUTH LIMIT.
4. CONSTRUCT GROAT ROAD SOUTHBOUND FROM STA. 164+00 TO STA 166+00.
5. CONSTRUCT RAMP EW-N.
6. CONSTRUCT RAMP N-E FROM GROAT BRIDGE TO EXIT NOSE.
7. CONSTRUCT EMILY MURPHY ROAD WESTBOUND AND EMILY MURPHY PARK RAMP.
8. CONSTRUCT DETOUR D-4 FROM OVERPASS STRUCTURE TO DETOUR D-1.

SCALE

100 0 200

		CONSTRUCTION STAGING	SHEET

EXHIBIT K-8

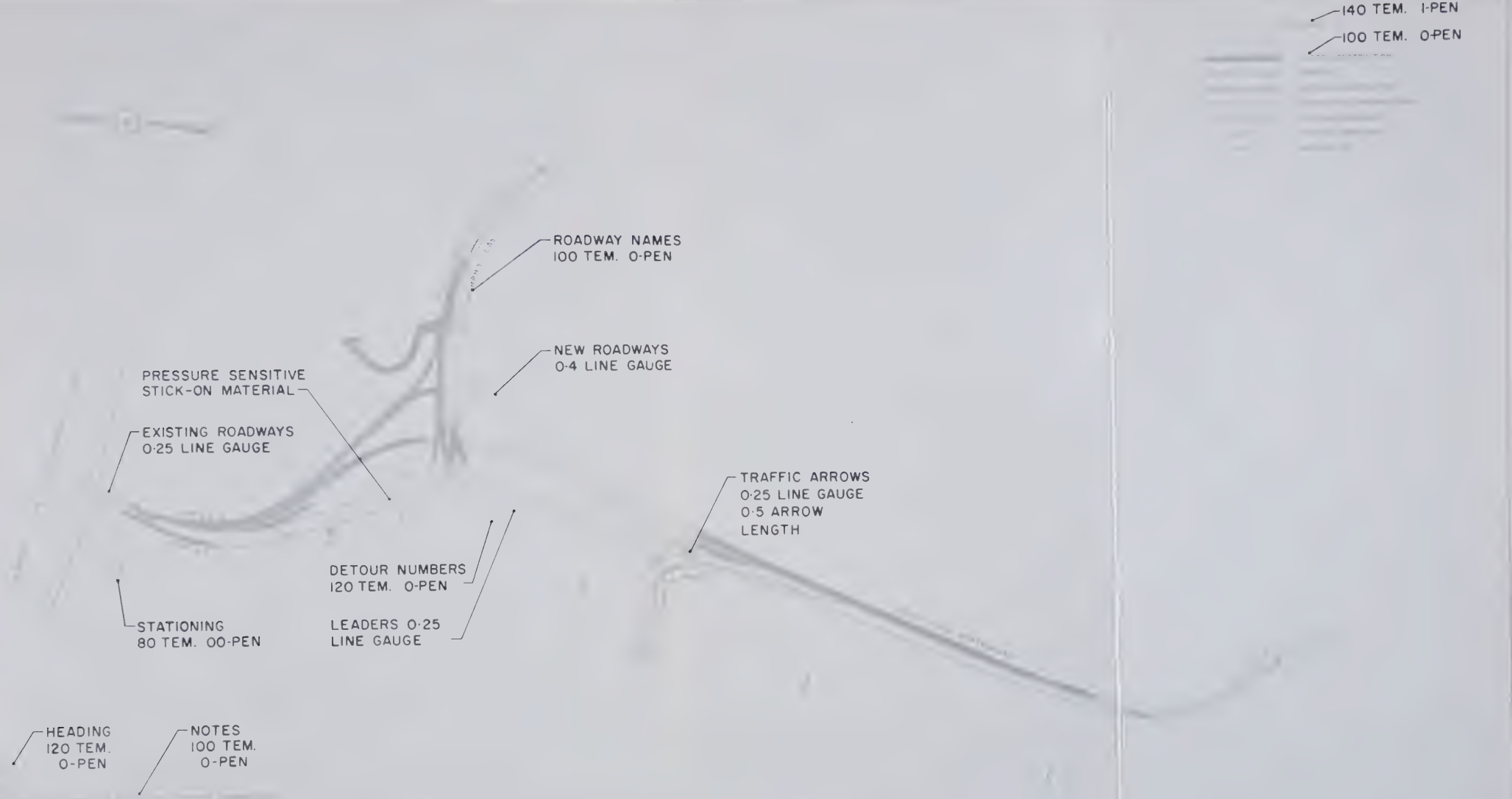
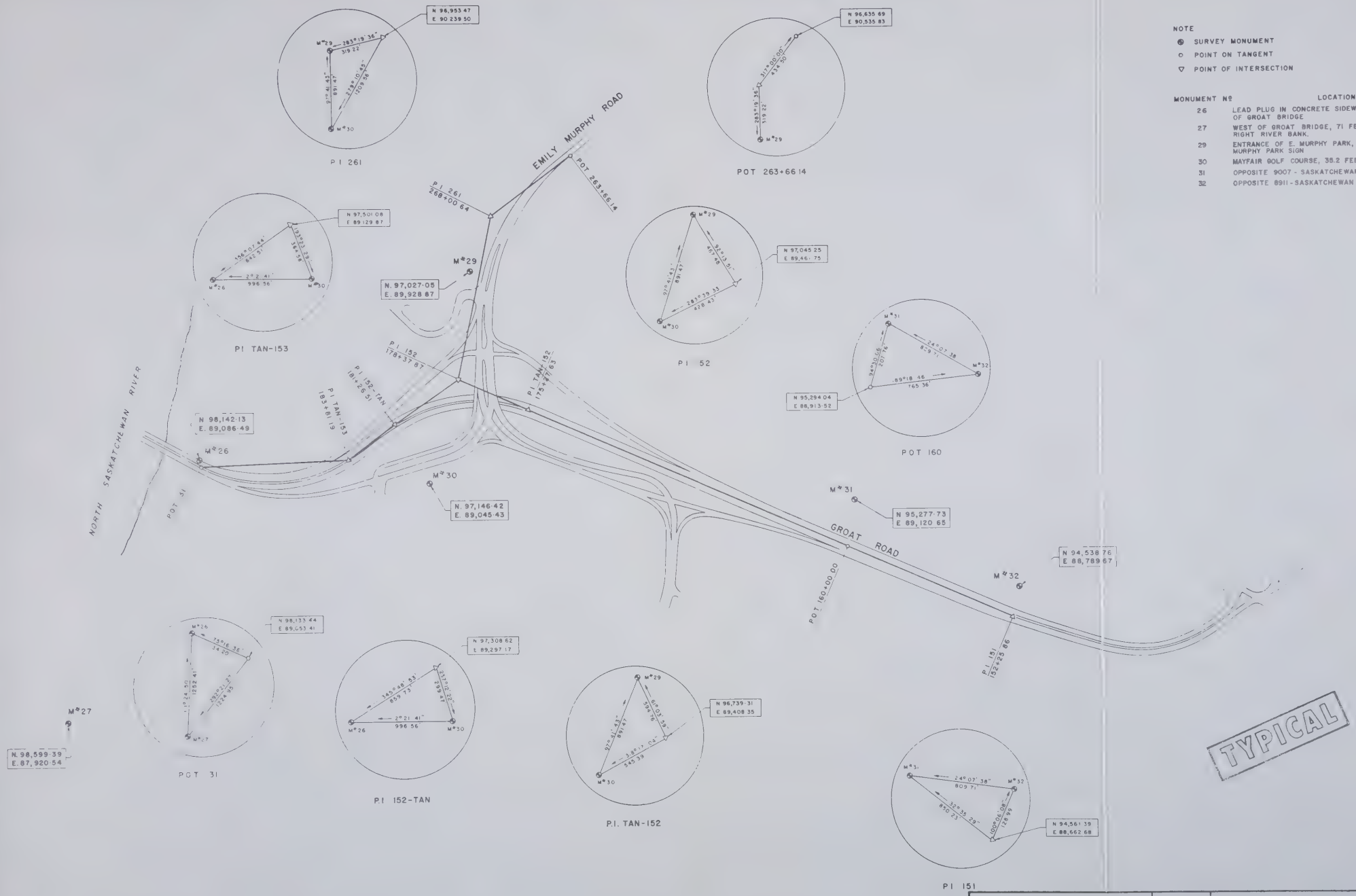

140 TEM. 1-PEN
100 TEM. 0-PEN
ROADWAY NAMES
100 TEM. 0-PEN
NEW ROADWAYS
0·4 LINE GAUGE
PRESSURE SENSITIVE
STICK-ON MATERIAL
EXISTING ROADWAYS
0·25 LINE GAUGE
TRAFFIC ARROWS
0·25 LINE GAUGE
0·5 ARROW
LENGTH
DETOUR NUMBERS
120 TEM. 0-PEN
LEADERS 0·25
LINE GAUGE
STATIONING
80 TEM. 00-PEN
HEADING
120 TEM.
0-PEN
NOTES
100 TEM.
0-PEN

EXHIBIT K-9



NOTE

- ⊕ SURVEY MONUMENT
- ○ POINT ON TANGENT
- ▽ POINT OF INTERSECTION

MONUMENT Nº	LOCATION
26	LEAD PLUG IN CONCRETE SIDEWALK ON SOUTH END OF GROAT BRIDGE
27	WEST OF GROAT BRIDGE, 71 FEET SOUTH OF TOP OF RIGHT RIVER BANK.
29	ENTRANCE OF E. MURPHY PARK, 63.2 FEET S.E. OF E. MURPHY PARK SIGN
30	MAYFAIR GOLF COURSE, 38.2 FEET S.E. OF FIRE HYDRANT.
31	OPPOSITE 9007 - SASKATCHEWAN DRIVE
32	OPPOSITE 8911 - SASKATCHEWAN DRIVE.

ALIGNMENT CONTROL
& TIES

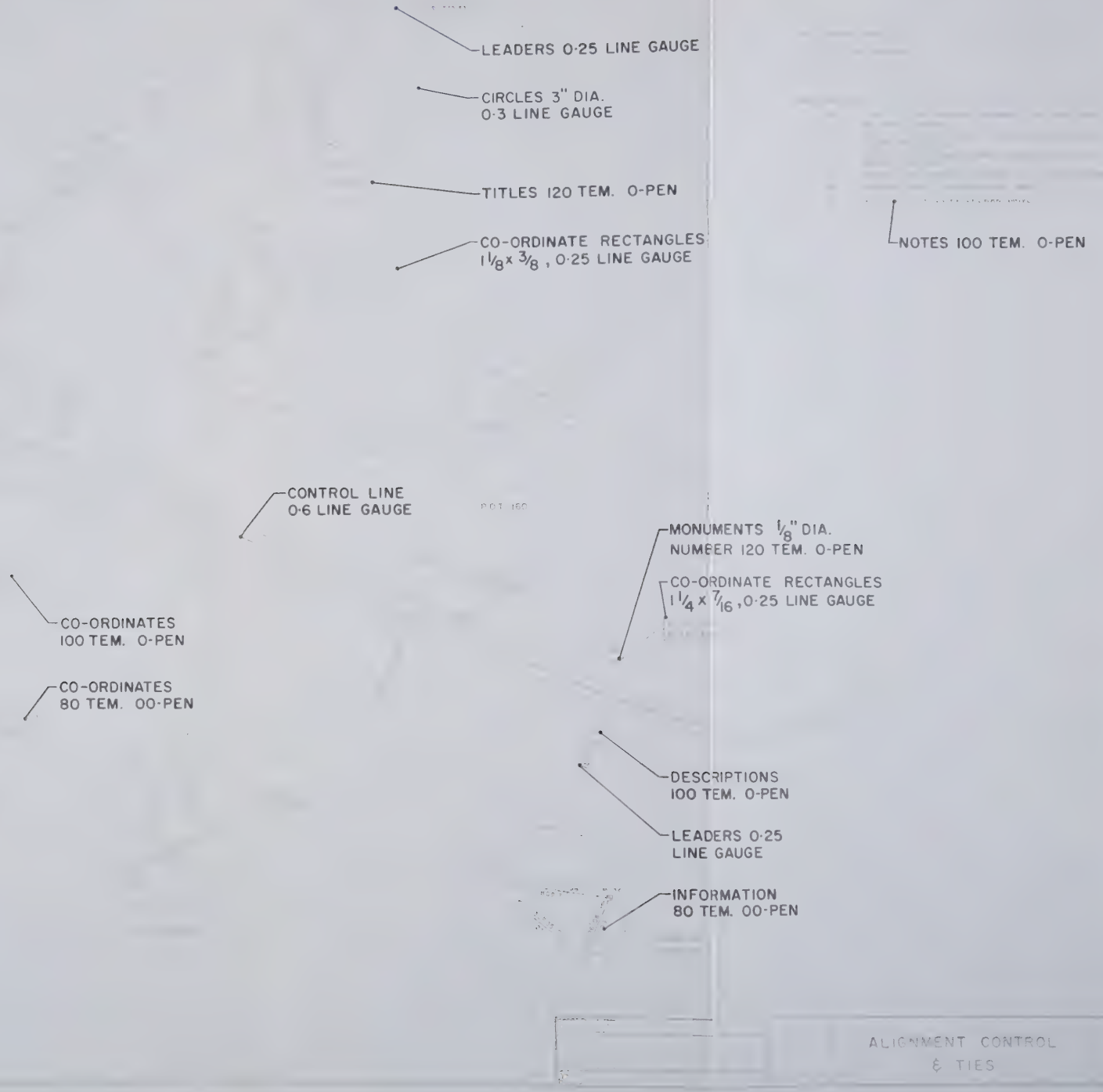

LEADERS 0·25 LINE GAUGE
CIRCLES 3" DIA.
0·3 LINE GAUGE
TITLES 120 TEM. 0-PEN
CO-ORDINATE RECTANGLES
1 1/8 x 3/8 , 0·25 LINE GAUGE
NOTES 100 TEM. 0-PEN
CONTROL LINE
0·6 LINE GAUGE
MONUMENTS 1/8" DIA.
NUMBER 120 TEM. 0-PEN
CO-ORDINATE RECTANGLES
1 1/4 x 7/16 , 0·25 LINE GAUGE
CO-ORDINATES
100 TEM. 0-PEN
CO-ORDINATES
80 TEM. 00-PEN
DESCRIPTIONS
100 TEM. 0-PEN
LEADERS 0·25
LINE GAUGE
INFORMATION
80 TEM. 00-PEN
ALIGNMENT CONTROL
& TIES

EXHIBIT K-11

RAMP E-N	
STATION	CO-ORDINATES
	NORTH / EAST
P.C.C. 155+71.85	86,365.97 / 84,365.98
P.C. 153+27.81	86,365.97 / 84,365.98
P.C. 152+29.84	86,365.97 / 84,365.98
E.C. 155+71.85	86,365.97 / 84,365.98
P.I.(c) 155+78.41	86,365.97 / 84,365.98
T.C. 155+84.98	86,365.97 / 84,365.98

RAMP E-N			
CIRCULAR CURVE DATA			
No.			
Δ	14° 00' 00"	2° 30' 00"	3° 30' 00"
D	409.26'	2291.83'	1637.02'
R	64.82'	347	
T	128.57'	689.25'	13.11'
L	5.10'	26.16'	0.01'
E			
SPIRAL DATA			
No.			
θs	8° 00' 00"		
Ls	400.00'	200.00'	
LT	270.08'	123.89'	
ST	136.44'		

SOUTH WEST BYPASS	
STATION	CO-ORDINATES
	NORTH / EAST
P.O.C.	
P.O.C.	
P.I.(c) 153+19.55	
P.I.	

SOUTH W. BYPASS	
CIRCULAR CURVE DATA	
No.	25
Δ	125° 00' 00"
D	4° 00' 00"
R	
T	317.55'
L	200.12'
E	100.11'
SPIRAL DATA	
No.	29
θs	7° 30' 00"
Ls	300.00'
LT	200.12'
ST	100.11'

SOUTH WEST BYPASS E.B.	
STATION	CO-ORDINATES
	NORTH / EAST
P.C.	84,888.66 / 87,183.23
P.I.	84,749.98 / 86,678.06

S.W. BYPASS E.B.	
CIRCULAR CURVE DATA	
No.	31
Δ	27° 00' 00"
D	4° 00' 00"
R	1432.39'
T	343.89
L	675.00'
E	40.70'
SPIRAL DATA	
No.	30
θs	8° 00' 00"
Ls	400.00'
LT	266.94'
ST	133.58'

SOUTH WEST BYPASS W.B.	
STATION	CO-ORDINATES
	NORTH / EAST
T.S. 360+98.92	85,058.98
P.O.T. 361+61.22	84,980.52 / 86,103.92
S.C. 364+98.92	84,768.31 / 86,341.31

S.W. BYPASS W.B.	
CIRCULAR CURVE DATA	
No.	32
Δ	4° 11' 30"
D	400.00
R	
T	146.42
L	293.58

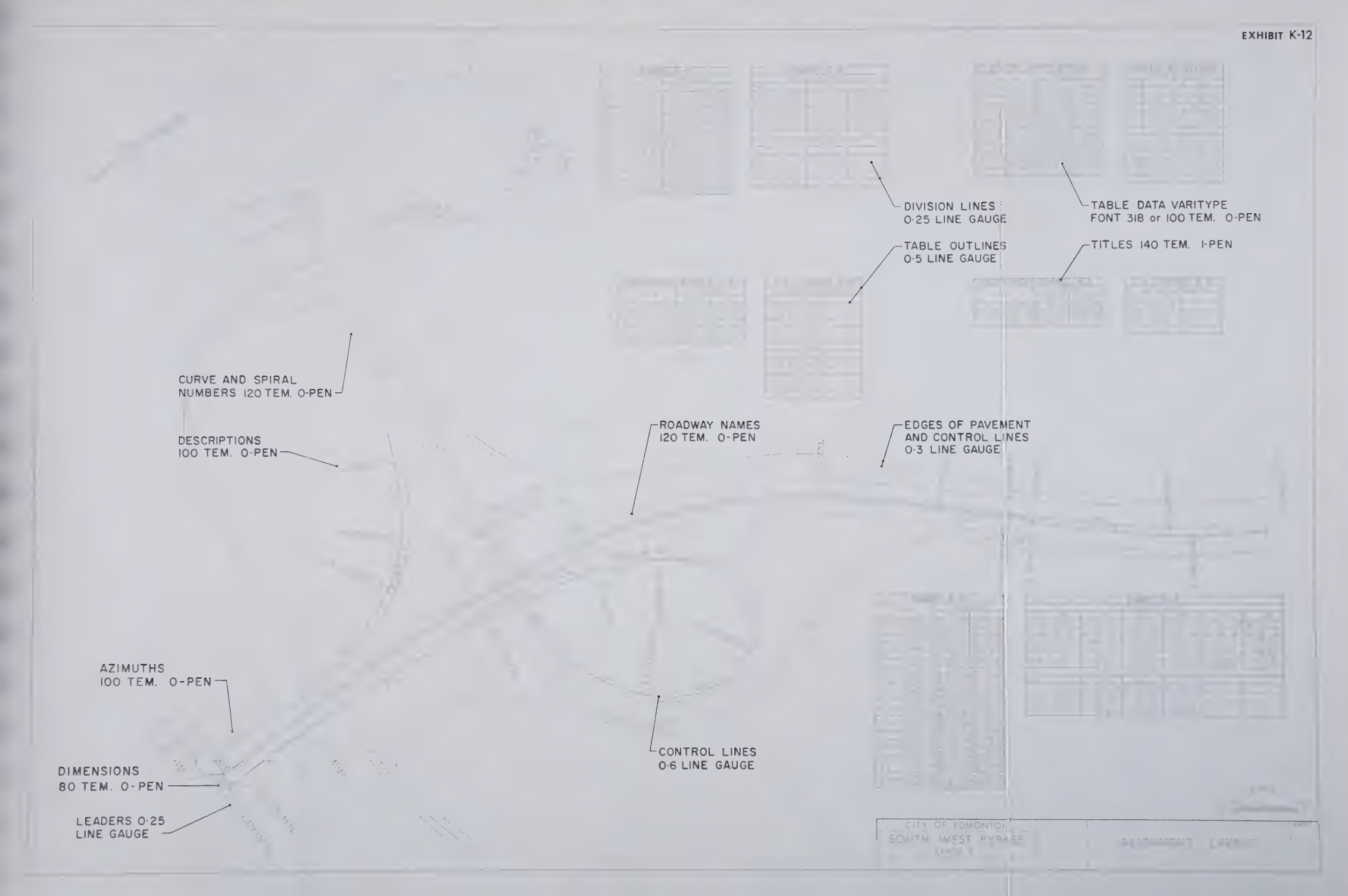
RAMP N-E		
STATION	CO-ORDINATES	
	NORTH	EAST
T.C. 239+43.56	87,347.12	83,170.36
P.I.(c) 239+49.06	87,341.63	83,170.65
P.C.C. 239+54.56	87,336.13	83,170.92
P.I.(c) 240+68.40	87,222.44	83,176.50
P.C.C. 241+82.11	87,108.65	83,173.00
P.I.(c) 244+35.77	86,855.11	83,165.33
C.S. 246+89.11	86,603.23	83,135.25
P.I.(s) 248+77.12	86,416.55	83,112.95
S.C. 249+89.11	86,309.61	83,076.52
P.I.(c) 250+67.73	86,235.38	83,051.23
C.S. 251+45.47	86,167.31	83,012.31
P.I.(s) 252+72.64	86,056.90	82,949.19
S.C. 253+45.47	86,032.63	82,871.01
P.I.(c) 254+72.17	85,995.08	82,750.00
C.S. 255+59.49	86,104.58	82,686.24
P.I.(s) 257+11.73	86,236.17	82,609.70
S.C. 258+59.49	86,376.27	82,748.83
P.I.(c) 259+64.17	86,450.55	82,822.60
C.S. 260+64.47	86,480.28	82,922.98
P.I.(s) 262+00.91	86,519.03	83,053.80
S.T. 264+64.47	86,465.19	83,318.06

RAMP N-E						
CIRCULAR CURVE DATA						
No.	200	201	204	206	208	
Δ	0° 16' 30"	4° 33' 01"	5° 04' 12"	110° 56' 43"	77° 02' 44"	28° 41' 52"
D	2° 30' 00"	1° 00' 00"	1° 00' 00"	7° 00' 00"	36° 00' 00"	14° 00' 00"
R	2291.83'	5729.58'	5729.58'	818.31'	159.15'	409.26'
T	5.50'	113.83'	253.67'	978.42'	126.72'	104.69'
L	11.00'	227.55'	507.00'	1584.76'	214.16'	204.98'
E	0.01'	2.26'	5.61'	844.27'	43.18'	13.18'
SPIRAL DATA						
No.	203	205	207	209		
θs	12° 00' 00"	43° 00' 00"	75° 00' 00"	28° 00' 00"		
Ls	300.00'	200.00'	300.00'	400.00'		
LT	188.01'	127.17'	192.45'	270.08'		
ST	112.97'	81.87'	152.25'	136.44'		

TYPICAL

SCALE
50 0 100

CITY OF EDMONTON		
SOUTH WEST BYPASS STAGE 1	ALIGNMENT LAYOUT	SHEET


DIVISION LINES
0·25 LINE GAUGE
TABLE DATA VARITYPE
FONT 318 or 100 TEM. 0-PEN
TABLE OUTLINES
0·5 LINE GAUGE
TITLES 140 TEM. 1-PEN
CURVE AND SPIRAL
NUMBERS 120 TEM. 0-PEN
DESCRIPTIONS
100 TEM. 0-PEN
ROADWAY NAMES
120 TEM. 0-PEN
EDGES OF PAVEMENT
AND CONTROL LINES
0·3 LINE GAUGE
AZIMUTHS
100 TEM. 0-PEN
CONTROL LINES
0·6 LINE GAUGE
DIMENSIONS
80 TEM. 0-PEN
LEADERS 0·25
LINE GAUGE
CITY OF EDMONTON
SOUTH WEST BYPASS

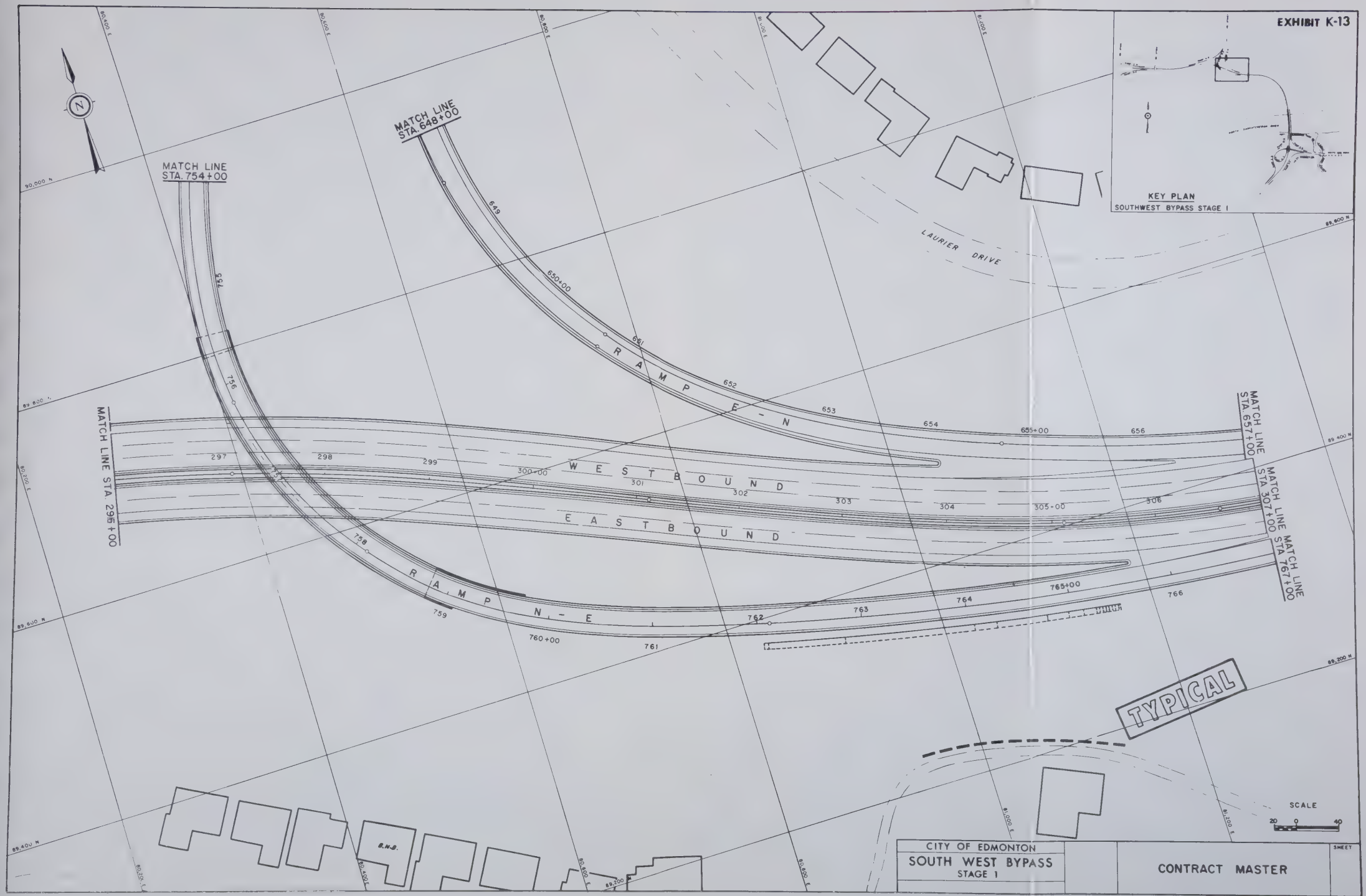
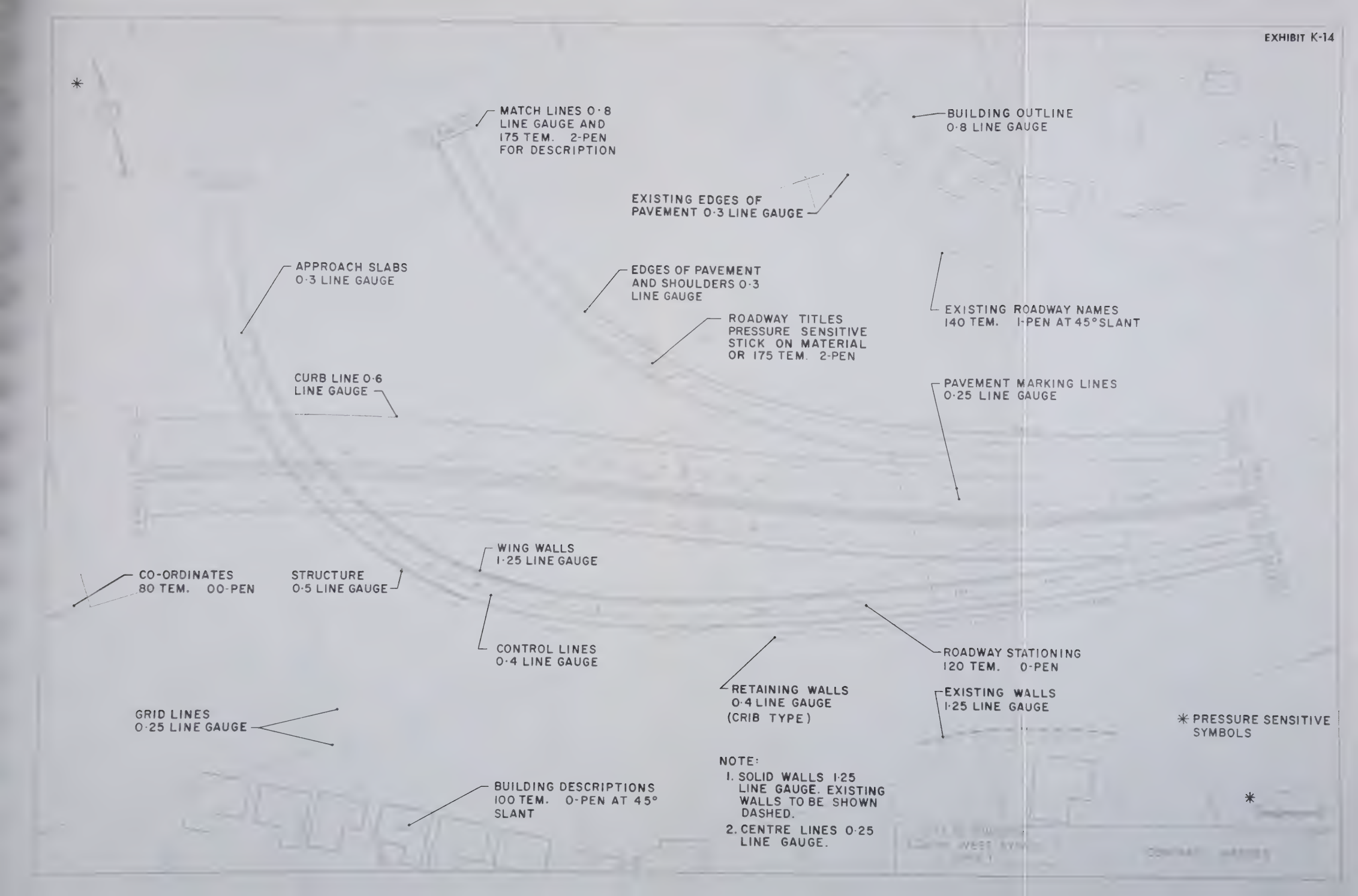


EXHIBIT K-13
KEY PLAN
SOUTHWEST BYPASS STAGE 1
MATCH LINE STA. 754+00
MATCH LINE STA. 648+00
MATCH LINE STA. 296+00
MATCH LINE STA. 657+00
MATCH LINE STA. 307+00
MATCH LINE STA. 767+00
LAURIER DRIVE
RAMP E-N
RAMP N-E
WESTBOUND
EASTBOUND
TYPICAL
SCALE
20 0 40
CITY OF EDMONTON
SOUTH WEST BYPASS
STAGE 1
CONTRACT MASTER
SHEET


MATCH LINES 0·8 LINE GAUGE AND 175 TEM. 2-PEN FOR DESCRIPTION
BUILDING OUTLINE 0·8 LINE GAUGE
EXISTING EDGES OF PAVEMENT 0·3 LINE GAUGE
APPROACH SLABS 0·3 LINE GAUGE
EDGES OF PAVEMENT AND SHOULDERS 0·3 LINE GAUGE
ROADWAY TITLES PRESSURE SENSITIVE STICK ON MATERIAL OR 175 TEM. 2-PEN
EXISTING ROADWAY NAMES 140 TEM. 1-PEN AT 45° SLANT
CURB LINE 0·6 LINE GAUGE
PAVEMENT MARKING LINES 0·25 LINE GAUGE
WING WALLS 1·25 LINE GAUGE
CO-ORDINATES 80 TEM. 00-PEN
STRUCTURE 0·5 LINE GAUGE
CONTROL LINES 0·4 LINE GAUGE
ROADWAY STATIONING 120 TEM. 0-PEN
RETAINING WALLS 0·4 LINE GAUGE (CRIB TYPE)
EXISTING WALLS 1·25 LINE GAUGE
GRID LINES 0·25 LINE GAUGE
* PRESSURE SENSITIVE SYMBOLS
BUILDING DESCRIPTIONS 100 TEM. 0-PEN AT 45° SLANT
NOTE:
1. SOLID WALLS 1·25 LINE GAUGE. EXISTING WALLS TO BE SHOWN DASHED.
2. CENTRE LINES 0·25 LINE GAUGE.

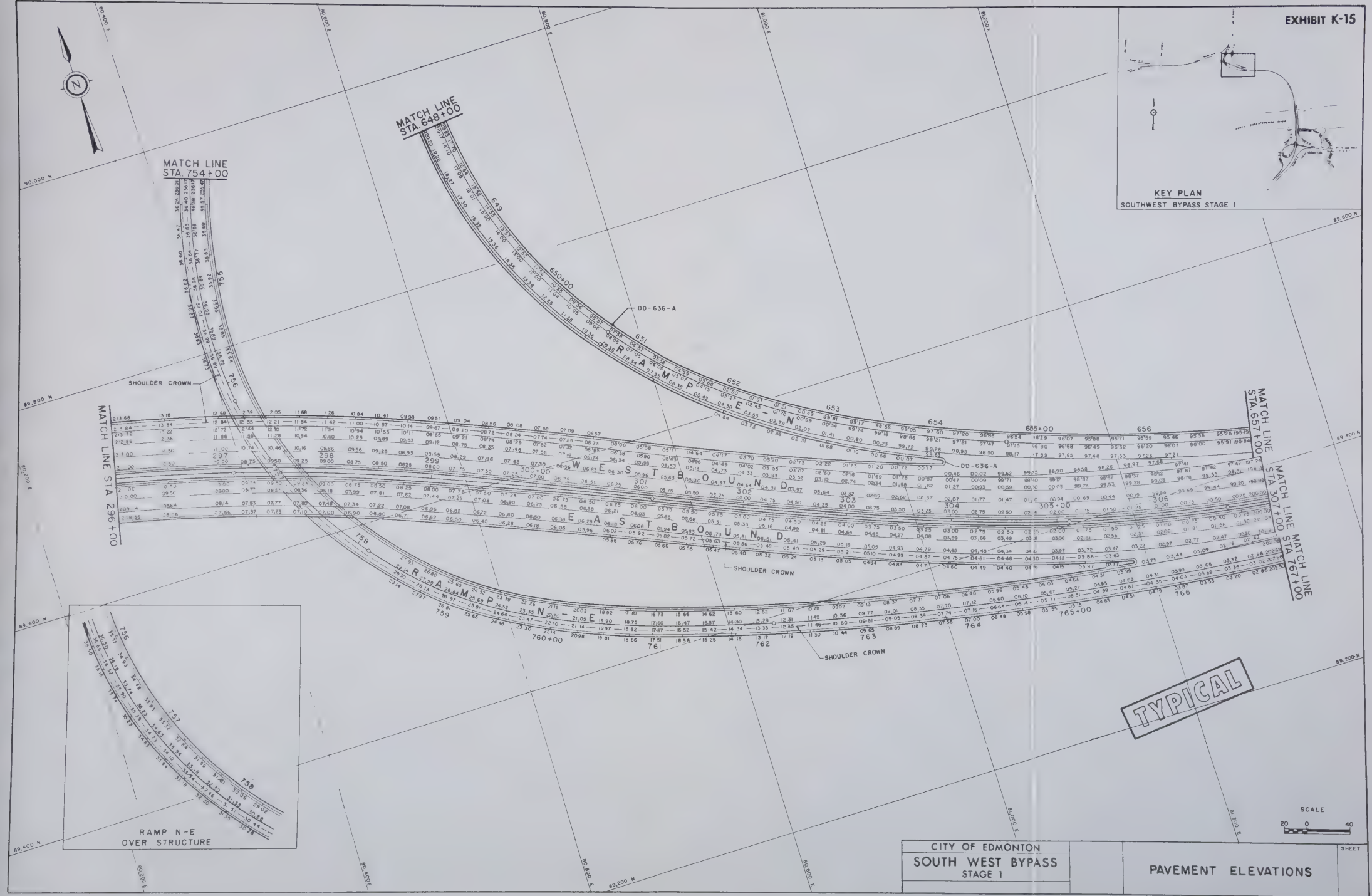
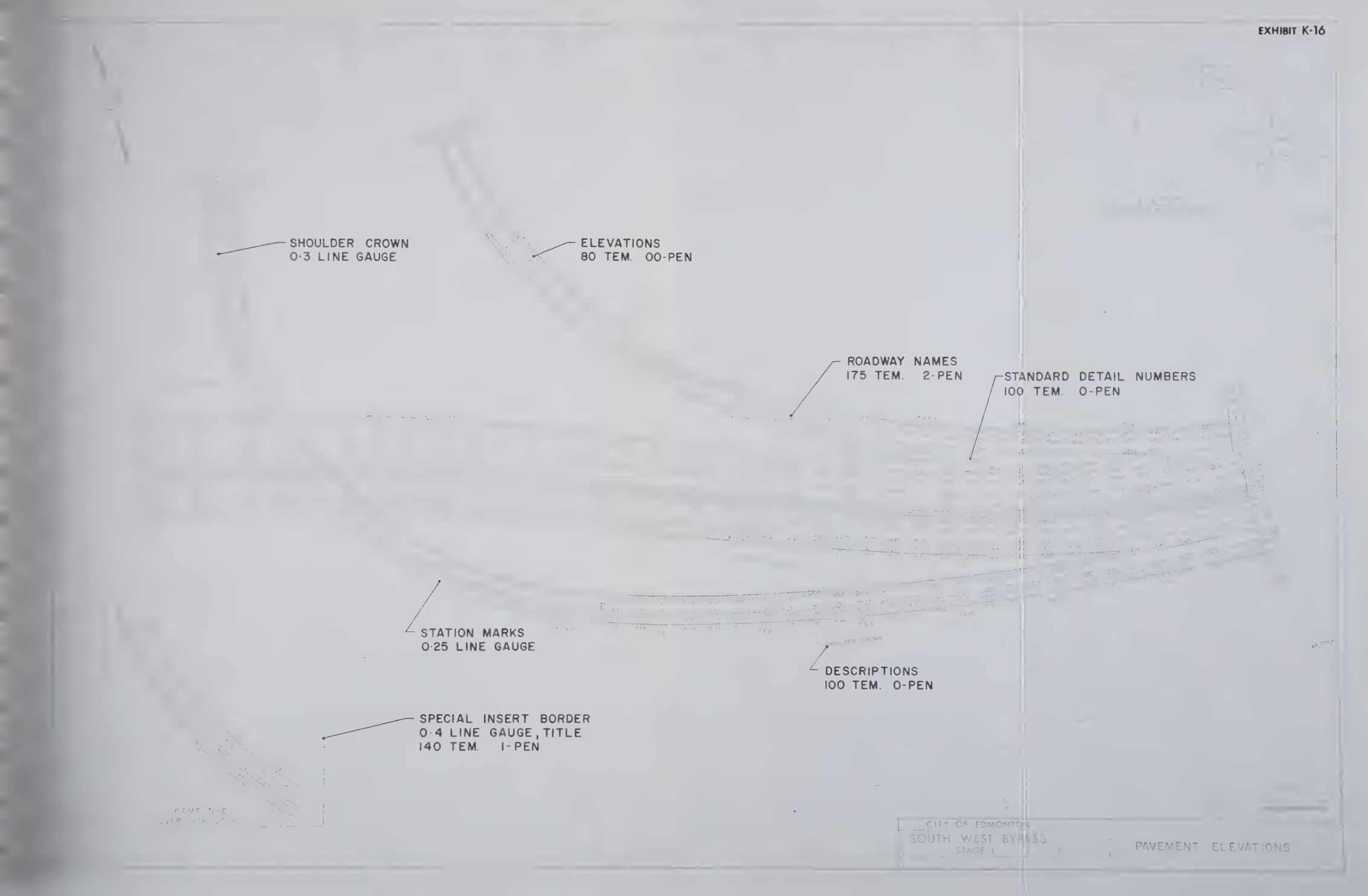


EXHIBIT K-15
KEY PLAN
SOUTHWEST BYPASS STAGE I
MATCH LINE STA. 754+00
MATCH LINE STA. 648+00
MATCH LINE STA. 296+00
MATCH LINE STA. 657+00
MATCH LINE STA. 767+00
SHOULDER CROWN
DD-636-A
RAMP N-E
RAMP E-S
RAMP S-W
RAMP W-N
RAMP E-N
RAMP S-E
RAMP N-W
RAMP W-S
RAMP N-E
OVER STRUCTURE
TYPICAL
SCALE
20 0 40
CITY OF EDMONTON
SOUTH WEST BYPASS
STAGE 1
PAVEMENT ELEVATIONS
SHEET


SHOULDER CROWN
0·3 LINE GAUGE
ELEVATIONS
80 TEM. 00-PEN
ROADWAY NAMES
175 TEM. 2-PEN
STANDARD DETAIL NUMBERS
100 TEM. 0-PEN
STATION MARKS
0·25 LINE GAUGE
DESCRIPTIONS
100 TEM. 0-PEN
SPECIAL INSERT BORDER
0·4 LINE GAUGE, TITLE
140 TEM. 1-PEN
CITY OF EDMONTON
SOUTH WEST BYPASS
STAGE 1
PAVEMENT ELEVATIONS

4½" CONCRETE
1" SAND CUSHION

9" CONCRETE

2" ASPHALT AC TYPE II
9" ASPHALTIC CONCRETE
6" CEMENT STABILIZED SUB-BASE

TYPE II & III CURB AND GUTTER (SEE SHEET R55)

3" ASPHALT AC TYPE II
6" CONCRETE
4" CEMENT STABILIZED SUB-BASE

TYPE I & II CURB AND GUTTER (SEE SHEET R55)

2" AC TYPE II
6" CONCRETE
4" GRANULAR SUB-BASE

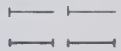
TYPE II CURB AND GUTTER (SEE SHEET R55)

2" AC TYPE II

8" CONCRETE SHOULDER
1" SAND CUSHION

(SEE SHEET R55)

SINGLE BOX BEAM GUARDRAIL TAPER



SINGLE BOX BEAM GUARDRAIL
BOX BEAM MEDIAN BARRIER

} (SEE SHEET R58)

DIRECTION OF TRAFFIC ARROWS

SIGN FOOTINGS

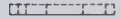
CHAIN LINK FENCE

TOP OF CUT OR TOE OF FILL

PIERS

CURB RETURN R = 2' (SEE SHEET R56)

BRIDGE PARAPET



RETAINING WALL

WING WALL

A - EDGE OF GUTTER
B - FACE OF CURB

LOW POINT
HIGH POINT

} DITCH FLOW

EXISTING DITCH

NEW DITCH

EXISTING R.O.W.

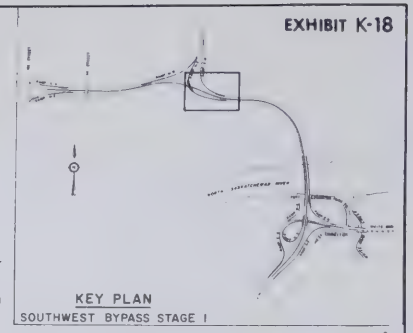
NEW R.O.W.

STANDARD FENCE

TYPICAL

CITY OF EDMONTON			SHEET
SOUTH WEST BYPASS STAGE 1		GRADING & PAVEMENT LEGEND	

EXHIBIT K-18



MATCH LINE STA. 754+00

MATCH LINE STA 648+00

MATCH LINE STA. 296+00

MATCH LINE STA 657+00

MATCH LINE STA 307+00

MATCH LINE STA 767+00

LAURIER DRIVE

RAMP 651 E-N

WESTBOUND

EASTBOUND

SEE TABLE BELOW

RAMP 761 N-E

RETAINING WALL

N 89,395·92
E 80,560·11

MEDIAN WIDTH	
STATION	½ WIDTH
299+00	8·0'
+25	7·91'
+50	7·72'
+75	7·47'
300+00	7·20'
+25	6·93'
+50	6·70'
+75	6·56'
301+00	6·5'

TYPICAL

SCALE
20 0 40

CITY OF EDMONTON		SHEET
SOUTH WEST BYPASS STAGE 1	GRADING & PAVEMENT DETAILS	

EXHIBIT K-19

* PRESSURE SENSITIVE LETTERS AND SYMBOLS

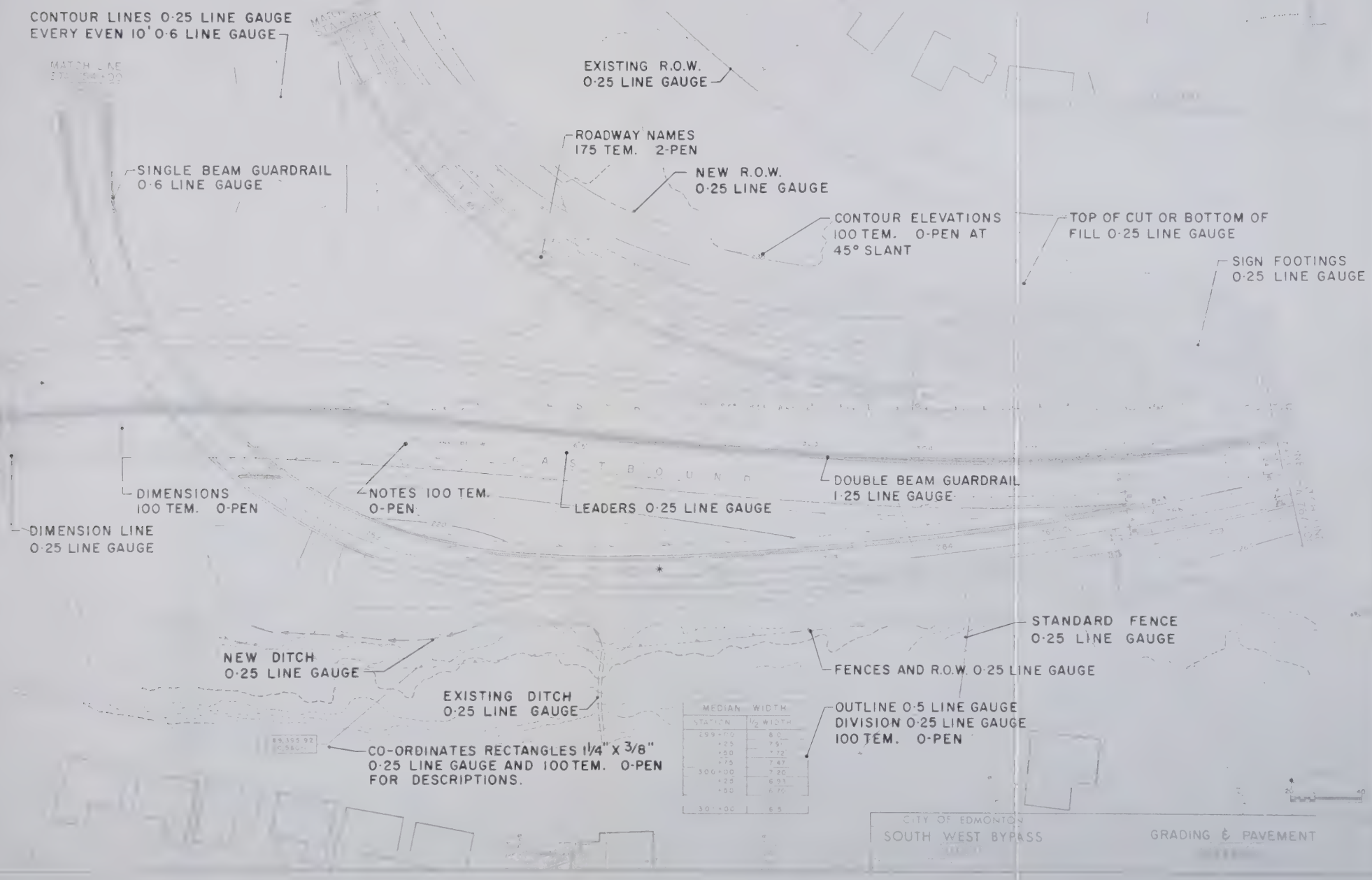
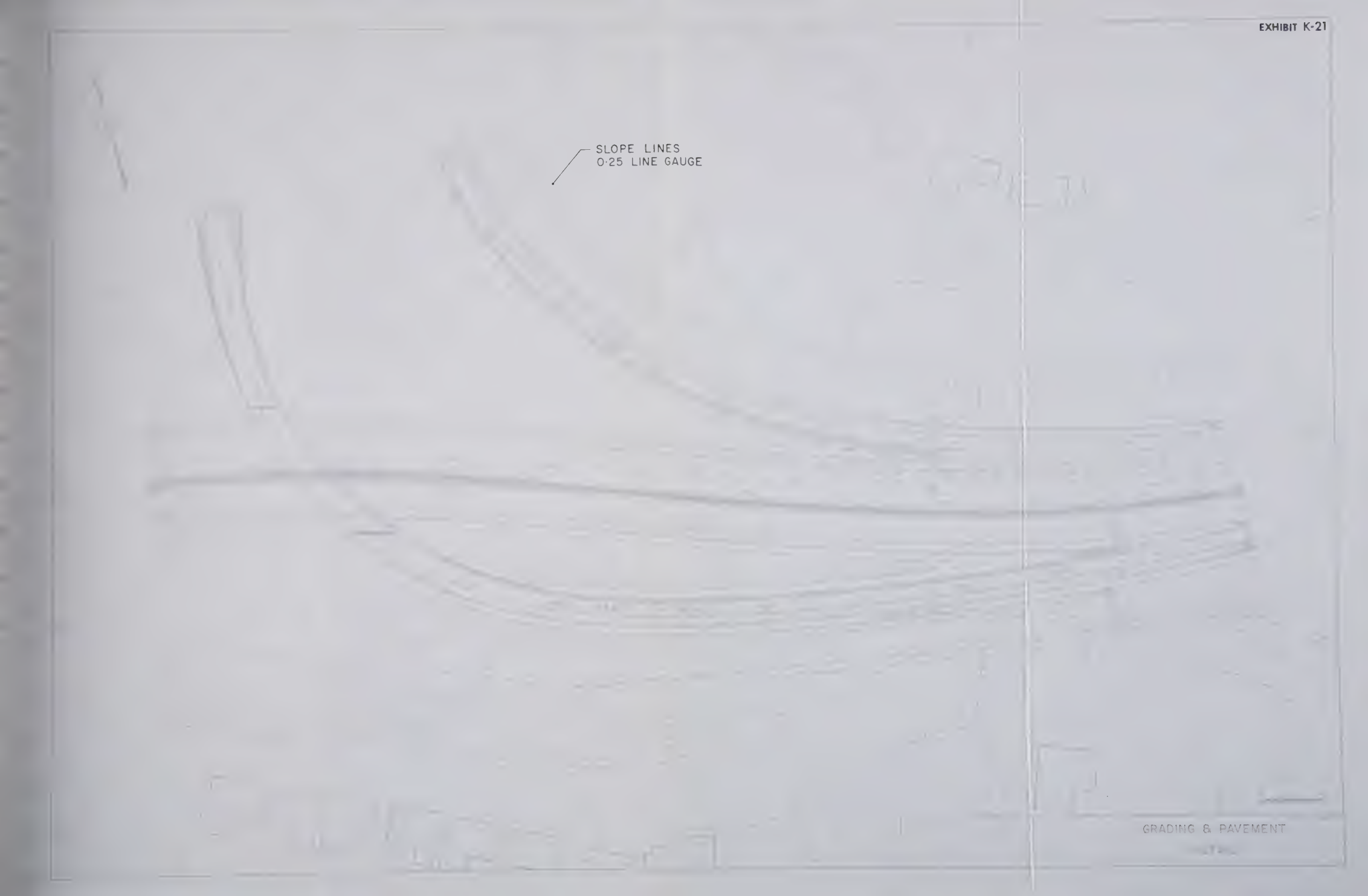

CONTOUR LINES 0·25 LINE GAUGE EVERY EVEN 10' 0·6 LINE GAUGE
EXISTING R.O.W. 0·25 LINE GAUGE
ROADWAY NAMES 175 TEM. 2-PEN
SINGLE BEAM GUARDRAIL 0·6 LINE GAUGE
NEW R.O.W. 0·25 LINE GAUGE
CONTOUR ELEVATIONS 100 TEM. 0-PEN AT 45° SLANT
TOP OF CUT OR BOTTOM OF FILL 0·25 LINE GAUGE
SIGN FOOTINGS 0·25 LINE GAUGE
DIMENSIONS 100 TEM. 0-PEN
NOTES 100 TEM. 0-PEN
LEADERS 0·25 LINE GAUGE
DOUBLE BEAM GUARDRAIL 1·25 LINE GAUGE
DIMENSION LINE 0·25 LINE GAUGE
NEW DITCH 0·25 LINE GAUGE
EXISTING DITCH 0·25 LINE GAUGE
STANDARD FENCE 0·25 LINE GAUGE
FENCES AND R.O.W. 0·25 LINE GAUGE
OUTLINE 0·5 LINE GAUGE
DIVISION 0·25 LINE GAUGE
100 TEM. 0-PEN
CO-ORDINATES RECTANGLES 1¼" X ⅜" 0·25 LINE GAUGE AND 100 TEM. 0-PEN FOR DESCRIPTIONS.
MEDIAN WIDTH
STATION
½ WIDTH
CITY OF EDMONTON
SOUTH WEST BYPASS
GRADING & PAVEMENT

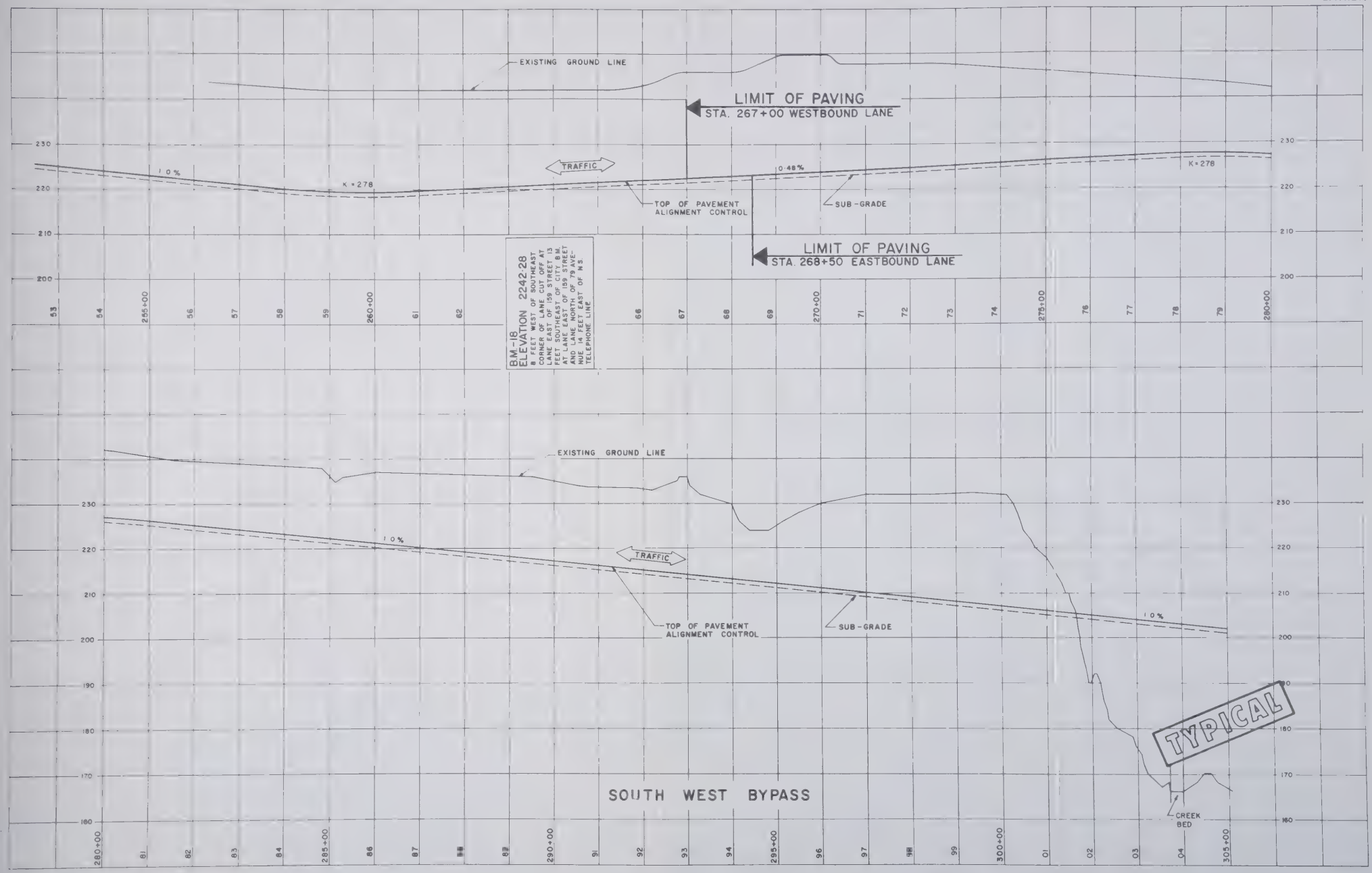
EXHIBIT K-20

LAURIER DRIVE
RAMP 651 E-N
RAMP 761 N-E
WESTBOUND
EASTBOUND
RETAINING WALL
TYPICAL
SCALE
20 0 40
GRADING & PAVEMENT DETAIL
SHEET



GRADING & PAVEMENT

EXHIBIT K-22



SCALES

HORIZONTAL 50 0 100

VERTICAL 5 0 10

CITY OF EDMONTON SOUTH WEST BYPASS STAGE 1	PAVEMENT PROFILES	SHEET

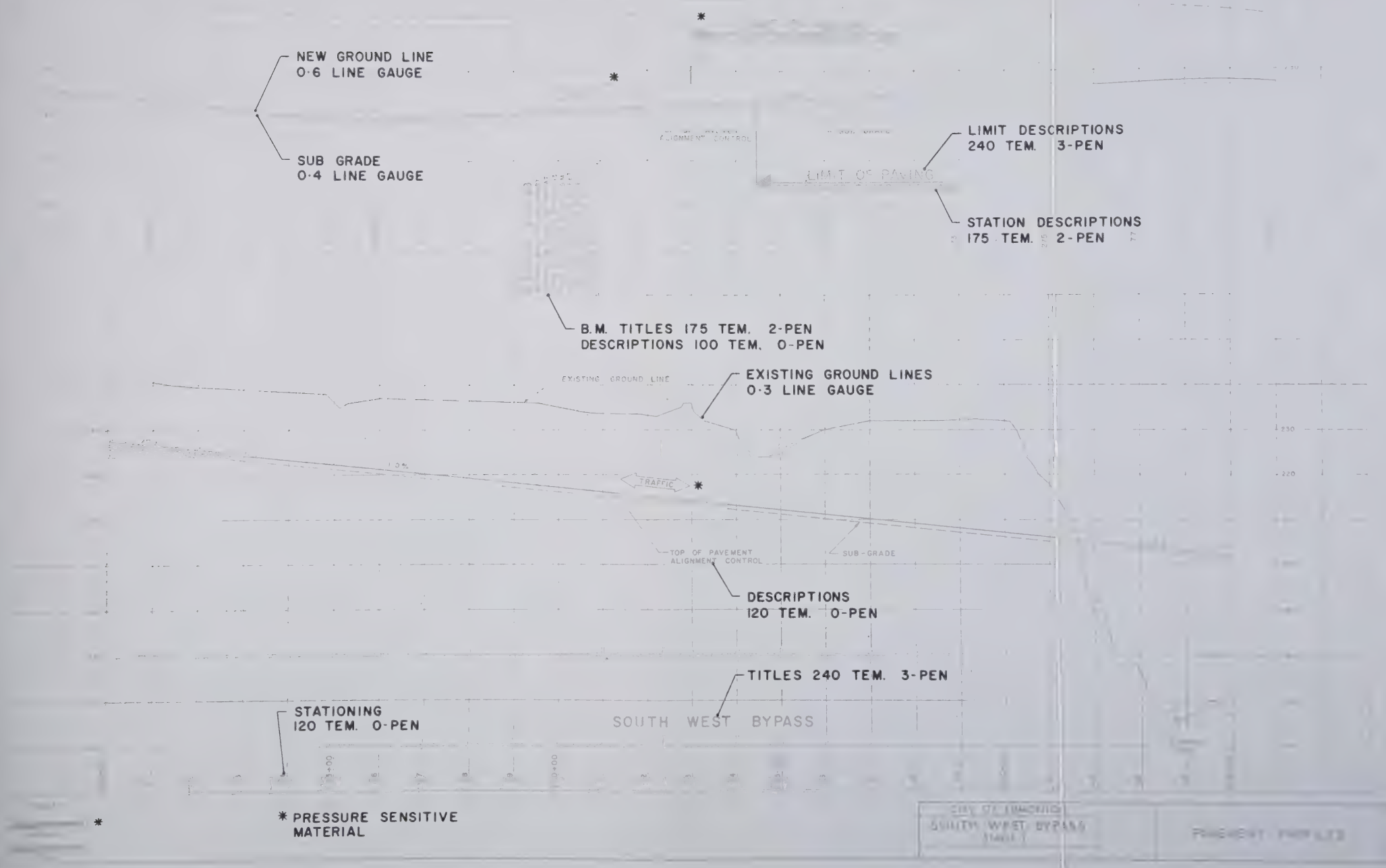
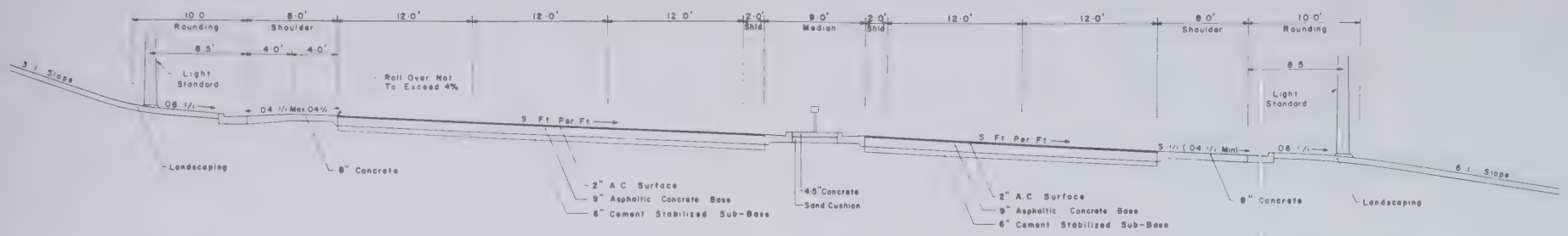
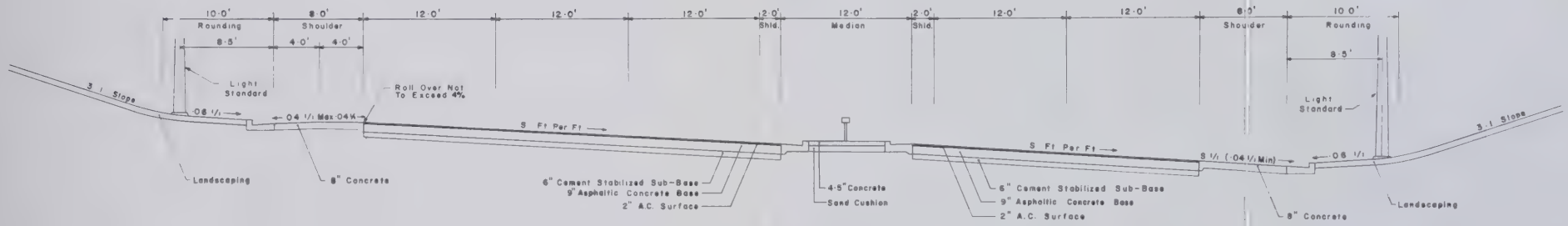

NEW GROUND LINE
0·6 LINE GAUGE
SUB GRADE
0·4 LINE GAUGE
LIMIT DESCRIPTIONS
240 TEM. 3-PEN
STATION DESCRIPTIONS
175 TEM. 2-PEN
B.M. TITLES 175 TEM. 2-PEN
DESCRIPTIONS 100 TEM. 0-PEN
EXISTING GROUND LINE
EXISTING GROUND LINES
0·3 LINE GAUGE
TRAFFIC
TOP OF PAVEMENT
ALIGNMENT CONTROL
SUB-GRADE
DESCRIPTIONS
120 TEM. 0-PEN
TITLES 240 TEM. 3-PEN
STATIONING
120 TEM. 0-PEN
SOUTH WEST BYPASS
* PRESSURE SENSITIVE
MATERIAL

EXHIBIT K-24

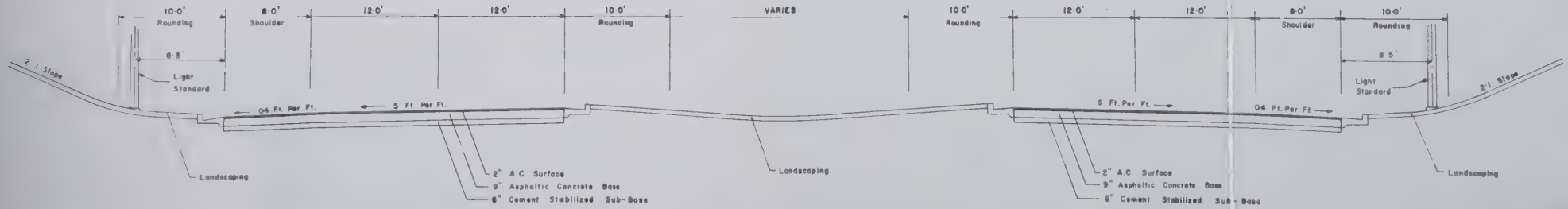


SOUTH WEST BYPASS IN THE VICINITY OF STA. 325+00
SECTION C-C



SOUTH WEST BYPASS IN THE VICINITY OF STA. 294+00
SECTION B-B

TYPICAL

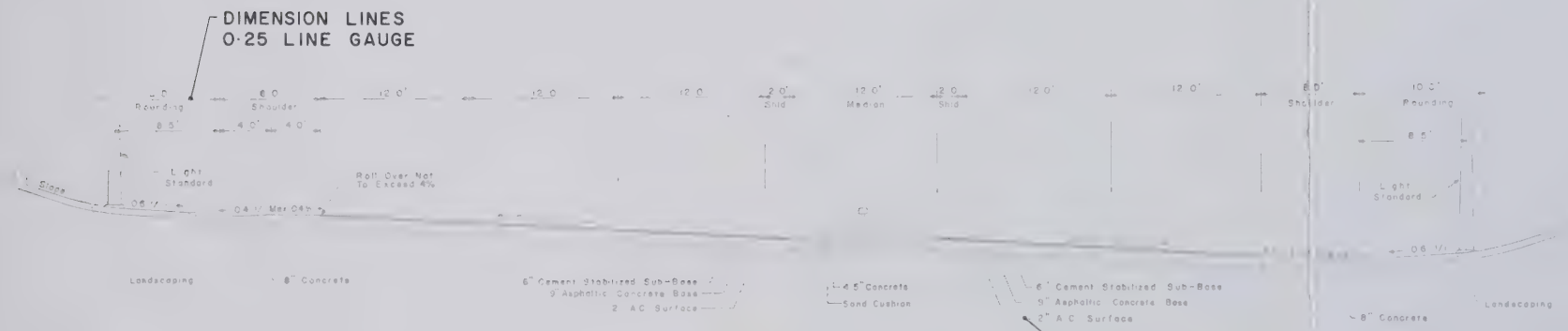


SOUTH WEST BYPASS IN THE VICINITY OF STA. 272+00
SECTION A-A

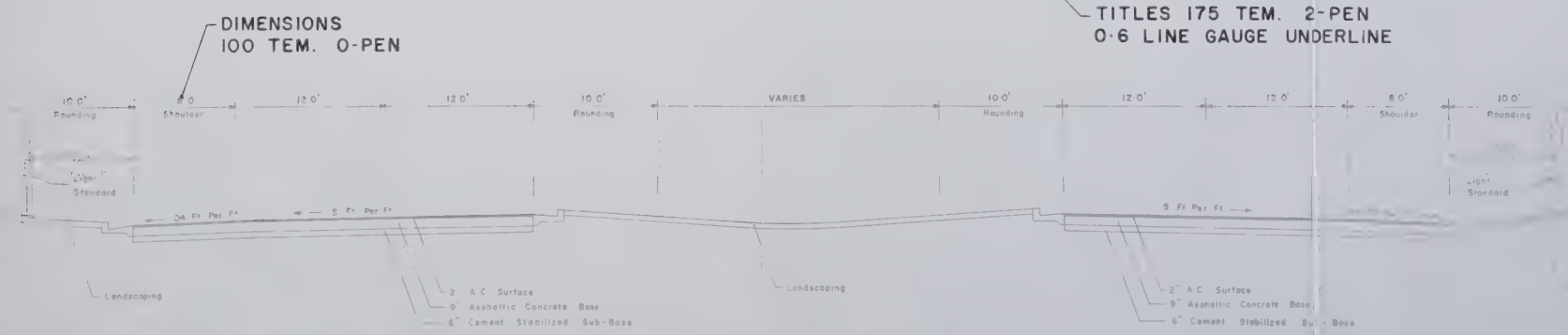
SCALE
2.5 0 5

CITY OF EDMONTON			SHEET
SOUTH WEST BYPASS STAGE 1		TYPICAL SECTIONS	

SOUTH WEST BYPASS IN THE VICINITY OF STA. 325+00
SECTION C - C



SOUTH WEST BYPASS IN THE VICINITY OF STA. 294+00
SECTION B-B



SOUTH WEST BYPASS IN THE VICINITY OF STA. 272+00
SECTION A - A

CITY OF EDMONTON
SOUTH WEST BYPASS
STAGE 1

TYPICAL SECTIONS

DRAINAGE

- EXISTING SEWERS
- NEW SEWERS
- CATCHBASIN MANHOLE
- 12" — ALL CLASSES OF CONCRETE PIPE
- NEW MANHOLE
- EXISTING MANHOLE
- EXISTING CATCHBASIN
- EXISTING RISER
- C43 — CATCHBASIN OR MANHOLE NUMBER
- S S — STANDARD STRENGTH
- DIRECTION OF FLOW

NOTE:

1. PIPE DATA FOR MINOR SEWERS AND DRAINS GIVEN IN STORM DRAIN SUMMARIES.
2. DATA FOR ALL CATCHBASINS AND MANHOLES GIVEN IN CATCHBASIN AND MANHOLE SUMMARIES
3. OFFSET DISTANCES IN CATCHBASIN AND MANHOLE SUMMARIES ARE SHOWN FOR THOSE MANHOLES AND CATCHBASINS THAT ARE NOT LOCATED IN GUTTERS. DISTANCES TO BE MEASURED FROM CONTROL LINE TO CENTER LINE OF FRAME.
4. CATCHBASINS ON CURBS
   THE LETTER STANDS FOR THE CURB LINE ON WHICH THE CATCHBASIN IS LOCATED (SEE LIST BELOW) THE NUMBER REPRESENTS THE NEAREST STATION
   EXAMPLE C15 - SOUTH WEST BYPASS WEST BOUND LT STATION 315+00
   - A SOUTH WEST BYPASS E B RT
   - B SOUTH WEST BYPASS E B LT
   - C SOUTH WEST BYPASS W B LT
   - D SOUTH WEST BYPASS W B RT
   - E RAMP N-E (149 STREET)
   - G RAMP E-N (149 STREET)
   - K RAMP N-W (149 STREET)
   - L RAMP N-E AND S-E (159 STREET)
   - M RAMP E-N AND E-S (159 STREET)
   - V DITCH CATCHBASIN
5. ALL CATCHBASIN CONNECTIONS ARE 10"Ø EXCEPT WHERE NOTED.

- CORRUGATED STEEL PIPE
- DOUBLE ENTRANCE CATCHBASIN
- EXISTING CULVERT
- NEW CULVERT
- SUBDRAIN

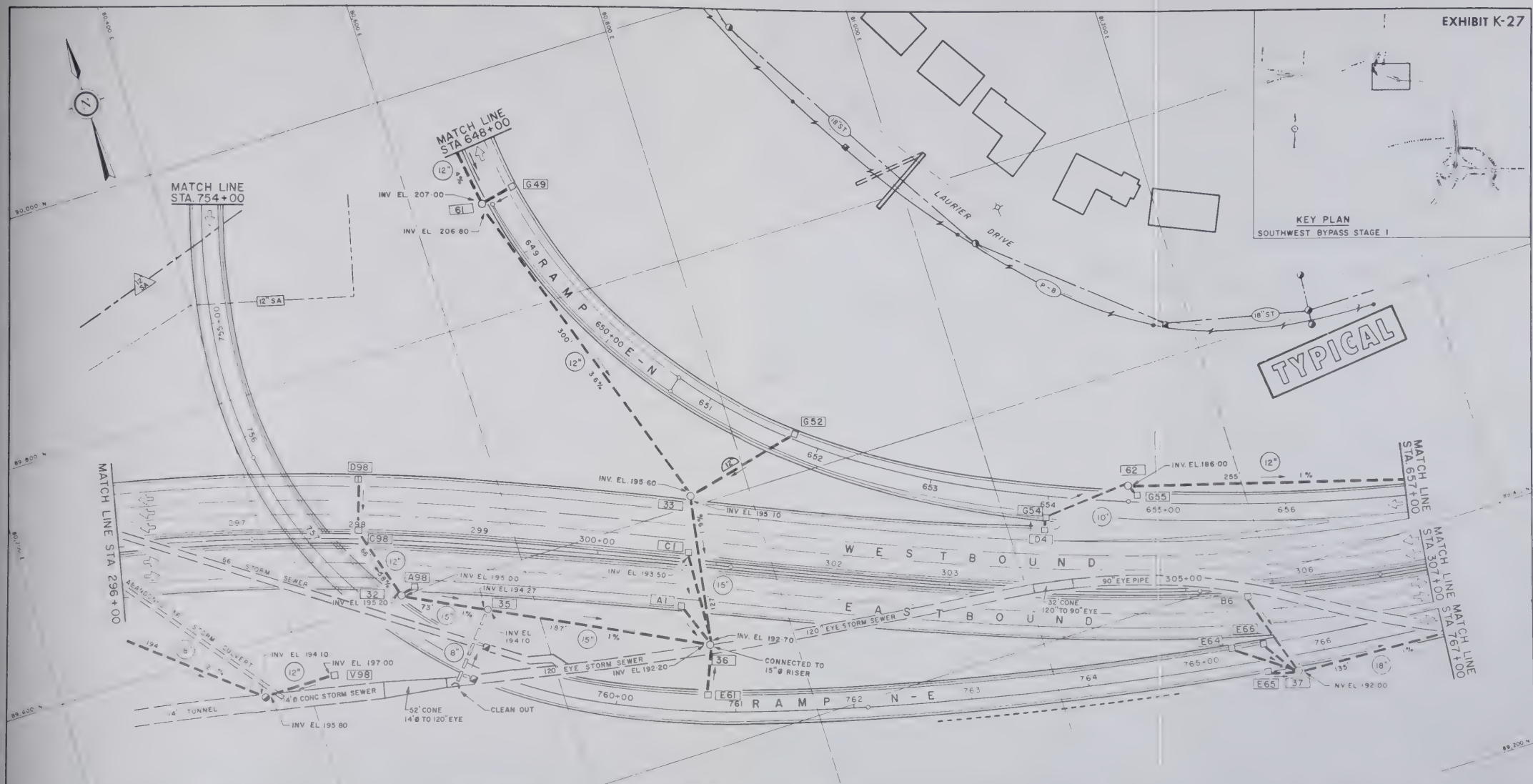
UTILITIES

- 12"ST — EXISTING STORM SEWER (ST).
- 12"ST — ABANDONED STORM SEWER
- 12"SA — EXISTING SANITARY SEWER (SA)
- 12"SA — ABANDONED SANITARY SEWER
- 12"GM — EXISTING GAS MAIN (G.M.)
- 12"GM — ABANDONED GAS MAIN
- 12"WM — EXISTING WATERMAIN (WM).
- 12"WM — ABANDONED WATERMAIN
- P-O — EXISTING POWER - OVERHEAD (P-O).
- P-B — EXISTING POWER-BURIED (P-B)
- T-O — EXISTING TELEPHONE CONDUIT OVERHEAD (T-O)
- T-B — EXISTING TELEPHONE CONDUIT BURIED (T-B).
- WATER VALVE CHAMBER (VC)
- HYDRANT (H).
- NEW MANHOLE
- EXISTING MANHOLE
- EXISTING GAS VALVE
- NEW UTILITIES
  - USE APPROPRIATE SYMBOL

TYPICAL

CITY OF EDMONTON SOUTH WEST BYPASS STAGE 1		DRAINAGE & UTILITIES LEGEND

EXHIBIT K-27



CATCHBASIN AND MANHOLE SUMMARY

NUMBER	LOCATION	STATION	OFFSET	TYPE	TYPE OF COVER	ELEVATION TOP/GRATE	ELEVATION LOW INVERT	REMARKS
A1	S WEST BYPASS	300+75		A	B	205.86	197.50	
A98	S WEST BYPASS	298+50		A	B	200.80	198.80	
B6	S WEST BYPASS	305+50		A	B	200.50	193.20	
C1	S WEST BYPASS	300+75		A	B	205.25	198.00	
C98	S WEST BYPASS	298+00		A	B	209.00	199.00	
D4	S WEST BYPASS	303+75		A	B	209.70	199.60	
D98	S WEST BYPASS	298+00		A	B	211.26	203.00	
E61	RAMP N-E	760+75		A	B	217.81	206.50	
E64	RAMP N-E	765+25		A	B	204.31	196.00	
E65	RAMP N-E	765+50		A	B	204.5	196.50	
E66	RAMP N-E	765+50		A	B	203.99	195.50	
G49	RAMP E-N	648+50		A	B	216.64	208.60	
G52	RAMP E-N	651+75		A	B	203.68	195.68	
G54	RAMP E-N	654+00		A	B	199.63	188.20	
G55	RAMP E-N	654+75		A	B	196.54	188.50	
V98	S WEST BYPASS	297+85	113 RT ℄	DITCH	GRATING	203.00	197.00	

STORM DRAIN SUMMARY

C.B.	TO C.B.	DIA	TYPE	LENGTH	INVERT ELEVATION UPSTM	INVERT ELEVATION DWNSTM	GRADE	REMARKS
A1	36	10"	S S	42'	197.50	195.00	6 %	
A98	32	10"	S S	12'	198.80	198.30	4.2%	
B6	37	10"	S S	75'	193.20	192.40	1.1%	
C1	36	10"	S S	84'	198.00	197.16	1 %	
C98	32	12"	S S	66'	199.00	195.20	5.8%	
D4	62	10"	S S	80'	187.20	186.20	1.2%	
D98	C98	10"	S S	45'	203.00	201.00	4.5%	
E61	36	10"	S S	42'	206.50	202.50	9.5%	
E64	37	10"	S S	60'	196.00	193.00	5 %	
E65	37	10"	S S	27'	196.50	196.00	1.8%	
E66	37	10"	S S	37'	195.50	195.00	1.4%	
G49	61	10"	S S	30'	208.60	208.00	2 %	
G52	33	10"	S S	105'	195.68	195.28	0.4%	
D4	G54	10"	S S	12'	191.60	191.00	5 %	
G55	62	10"	S S	12'	188.50	188.00	4 %	
V98	EX M H	12"	S S	60'	197.00	195.80	2 %	

CATCHBASIN AND MANHOLE SUMMARY

NUMBER	LOCATION	STATION	OFFSET	TYPE	TYPE OF COVER	ELEVATION TOP/GRATE	ELEVATION LOW INVERT	REMARKS
32	S WEST BYPASS	298+40	46 RT ℄	A	A	206.95	195.00	
33	S WEST BYPASS	300+75	56 LT ℄	A	A	206.60	195.10	
35	S WEST BYPASS	299+12	54 RT ℄	A	A	208.50	194.10	
36	S WEST BYPASS	301+04	66 RT ℄	B	A	211.50	192.20	
37	RAMP N-E	765+75	14 RT ℄	A	A	204.29	192.00	
61	RAMP E-N	648+50	8 RT ℄	A	A	218.80	208.80	
62	RAMP E-N	654+67	14 LT ℄	A	A	197.16	186.00	

STORM DRAIN SUMMARY

C.B.	TO C.B.	DIA	TYPE	LENGTH	INVERT ELEVATION UPSTM	INVERT ELEVATION DWNSTM	GRADE	REMARKS
32	35	15"	S S	73'	195.00	194.27	1%	
33	36	15"	S S	127'	195.10	192.20	9%	
35	36	15"	S S	187'	194.10	192.20	1%	
36	EX RISER	15"	S S		192.20			
37	38	18"	S S	135'	192.00	190.60	1 %	
61	33	12"	S S	300'	208.80	195.60	3.6%	
62	63	12"	S S	255'	186.00	183.45	1 %	

SCALE
20 0 40

CITY OF EDMONTON
SOUTH WEST BYPASS
STAGE 1

DRAINAGE & UTILITIES

SHEET

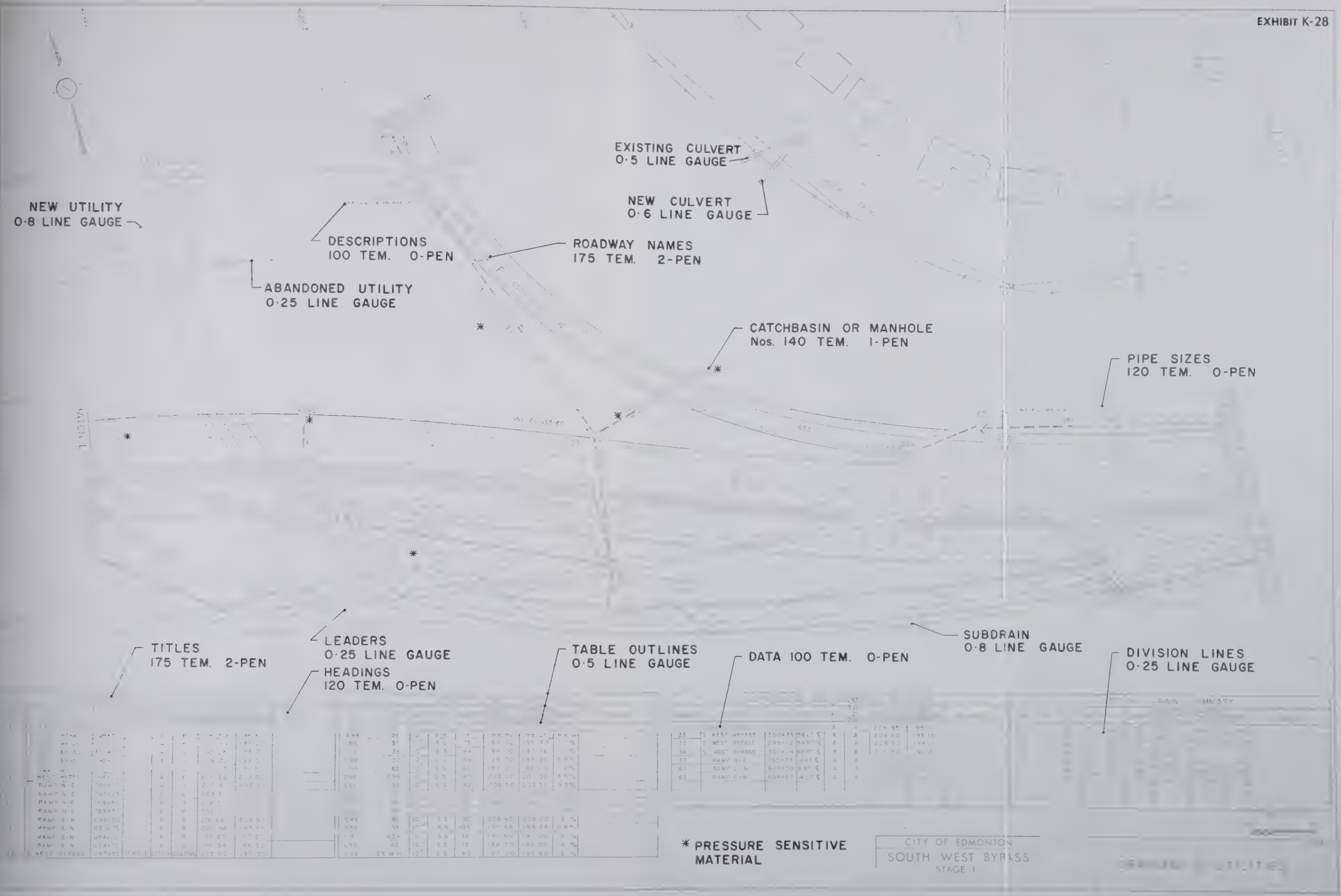
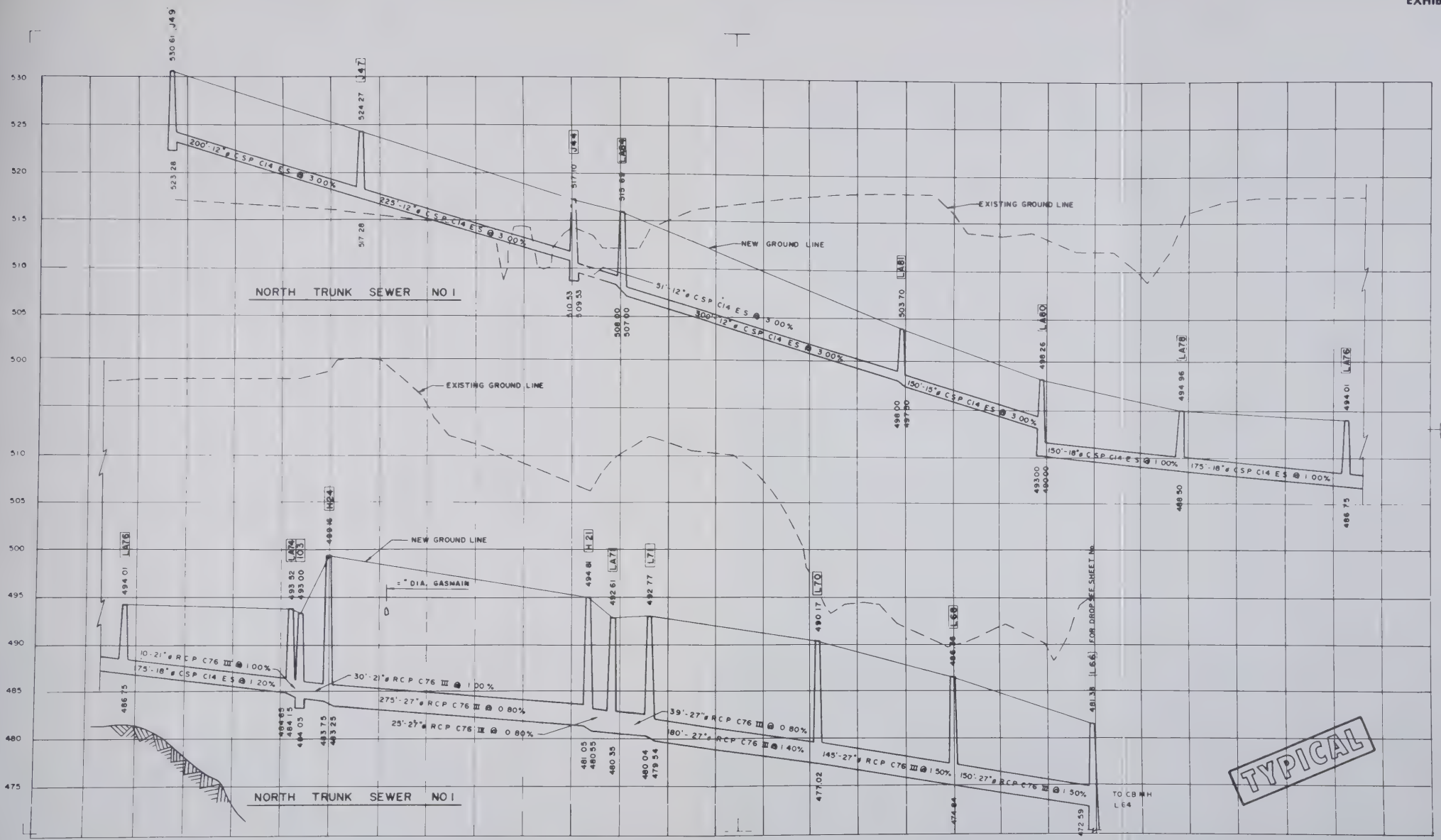

EXISTING CULVERT
0·5 LINE GAUGE
NEW CULVERT
0·6 LINE GAUGE
NEW UTILITY
0·8 LINE GAUGE
DESCRIPTIONS
100 TEM. 0-PEN
ROADWAY NAMES
175 TEM. 2-PEN
ABANDONED UTILITY
0·25 LINE GAUGE
CATCHBASIN OR MANHOLE
Nos. 140 TEM. 1-PEN
PIPE SIZES
120 TEM. 0-PEN
TITLES
175 TEM. 2-PEN
LEADERS
0·25 LINE GAUGE
HEADINGS
120 TEM. 0-PEN
TABLE OUTLINES
0·5 LINE GAUGE
DATA 100 TEM. 0-PEN
SUBDRAIN
0·8 LINE GAUGE
DIVISION LINES
0·25 LINE GAUGE
* PRESSURE SENSITIVE MATERIAL
CITY OF EDMONTON
SOUTH WEST BYPASS
STAGE 1

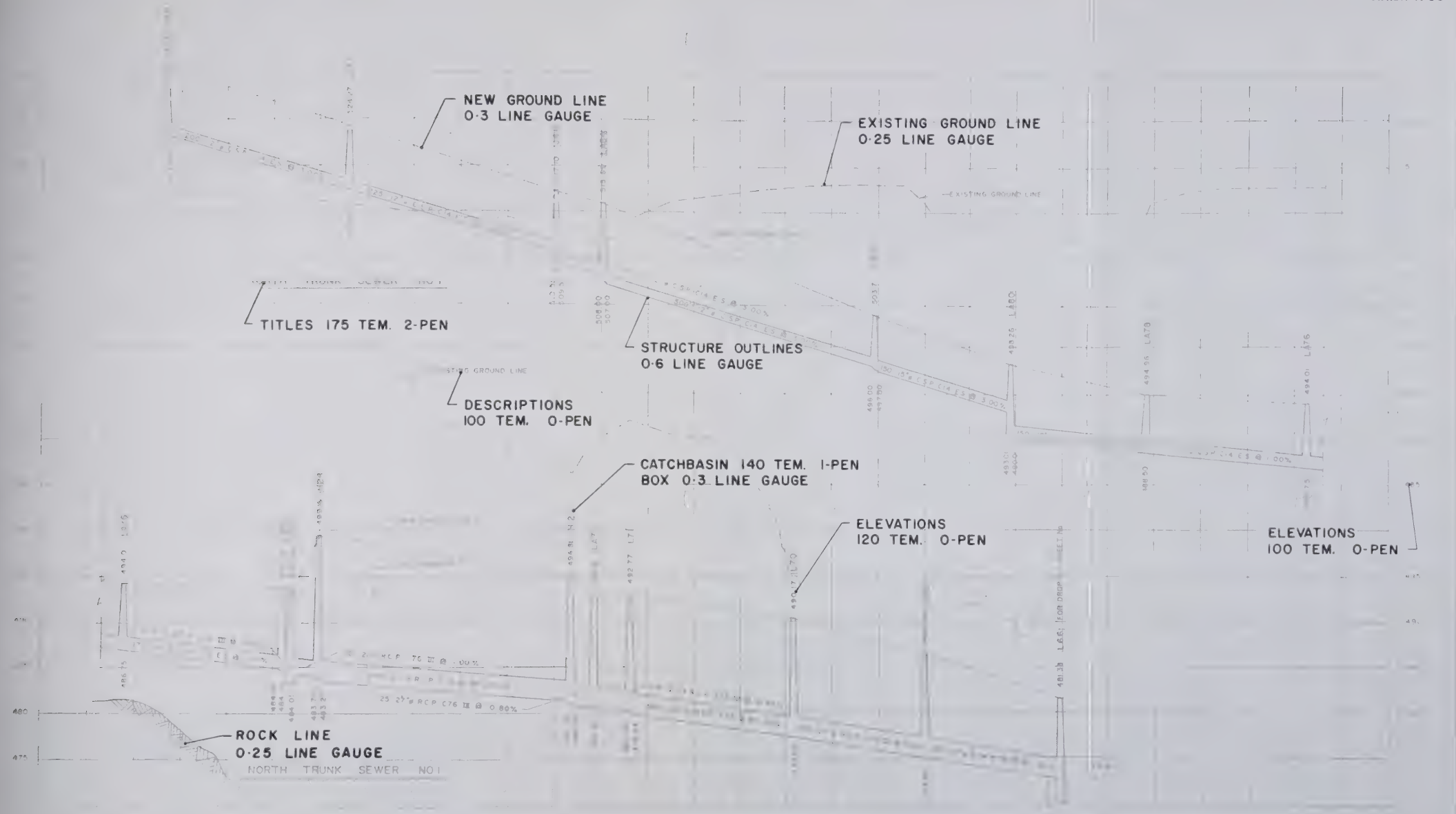
EXHIBIT K-29


NORTH TRUNK SEWER NO 1
NEW GROUND LINE
EXISTING GROUND LINE
200'-12"ø C.S.P. C14 E.S. @ 3.00%
225'-12"ø C.S.P. C14 E.S. @ 3.00%
51'-12"ø C.S.P. C14 E.S. @ 3.00%
300'-12"ø C.S.P. C14 E.S. @ 3.00%
150'-15"ø C.S.P. C14 E.S. @ 3.00%
150'-18"ø C.S.P. C14 E.S. @ 1.00%
175'-18"ø C.S.P. C14 E.S. @ 1.00%
10'-21"ø R.C.P. C76 III @ 1.00%
75'-18"ø C.S.P. C14 E.S. @ 1.20%
30'-21"ø R.C.P. C76 III @ 1.00%
275'-27"ø R.C.P. C76 III @ 0.80%
25'-27"ø R.C.P. C76 III @ 0.80%
39'-27"ø R.C.P. C76 III @ 0.80%
80'-27"ø R.C.P. C76 III @ 1.40%
145'-27"ø R.C.P. C76 III @ 1.50%
150'-27"ø R.C.P. C76 III @ 1.50%
= "DIA. GASMAIN
TO CB MH L64
FOR DROP SEE SHEET No
TYPICAL
SCALES
25 0 50
Horizontal
25 0 5
Vertical

SOUTH WEST BYPASS
STAGE 1

DRAINAGE PROFILES

EXHIBIT K-30



SOUTH WEST BYPASS
STAGE 1

DRAINAGE PROFILES

SPECIAL 42'-0" CONCRETE POLE TO BE COMBINATION LIGHTING AND ANCHOR POLE.

SPUN CONCRETE POLE 50 FT. MOUNTING HEIGHT WITH TRUSS BRACKET.

SPUN CONCRETE POLE 38 FT. MOUNTING HEIGHT WITH TRUSS BRACKET.

STEEL LIGHTING POLE 32 FT. MOUNTING HEIGHT WITH TRUSS BRACKET

SPUN CONCRETE POLE 30 FT. MOUNTING HEIGHT SINGLE TAPERED ELLIPTICAL ALUMINUM BRACKET.

EXISTING WOOD POLE AND LUMINAIRE

FLUORESCENT LUMINAIRE

A — 400 WATT MERCURY VAPOUR LUMINAIRE TYPE 3 DISTRIBUTION 347 VOLT INTEGRAL BALLAST 400 WATT CLEAR MERCURY LAMP A.S.A. DESIGNATION H33-1CD

A1 — 400 WATT MERCURY VAPOUR LUMINAIRE TYPE 3 DISTRIBUTION 120 VOLT INTEGRAL BALLAST 400 WATT WHITE MERCURY LAMP A.S.A. DESIGNATION H33-1GL/W.

JB No.12 — ROUND CONCRETE JUNCTION BOX No.12.

MH No.2 — TYPE I CONCRETE MANHOLE AND COVER No.2.

CONDUIT BANK

SECONDARY CABLES IN POLYETHYLENE PIPE.

ASBESTOS CEMENT CONDUIT IN STRUCTURES.

H.V. CABLE DIRECT BURIAL

D.B — DIRECT BURIED

G — 3/4" x 10'-0" GROUND ROD COPPER CLAD

T S No 5 — OVERHEAD TRAFFIC SIGN No 5

T S No.6 — CANTILEVER TRAFFIC SIGN No 6

C-1 — LIGHTING POLE NUMBER (PREFIX C INDICATES FOR CONSTRUCTION ONLY).

2 — UNDERPAVEMENT CROSSING NUMBER

B05

- B = SUPPLY TRANSFORMER
- O = COLOUR OF CABLE.
- 5 = BREAKER OR CIRCUIT NUMBER

CIRCUIT COLOUR CODE

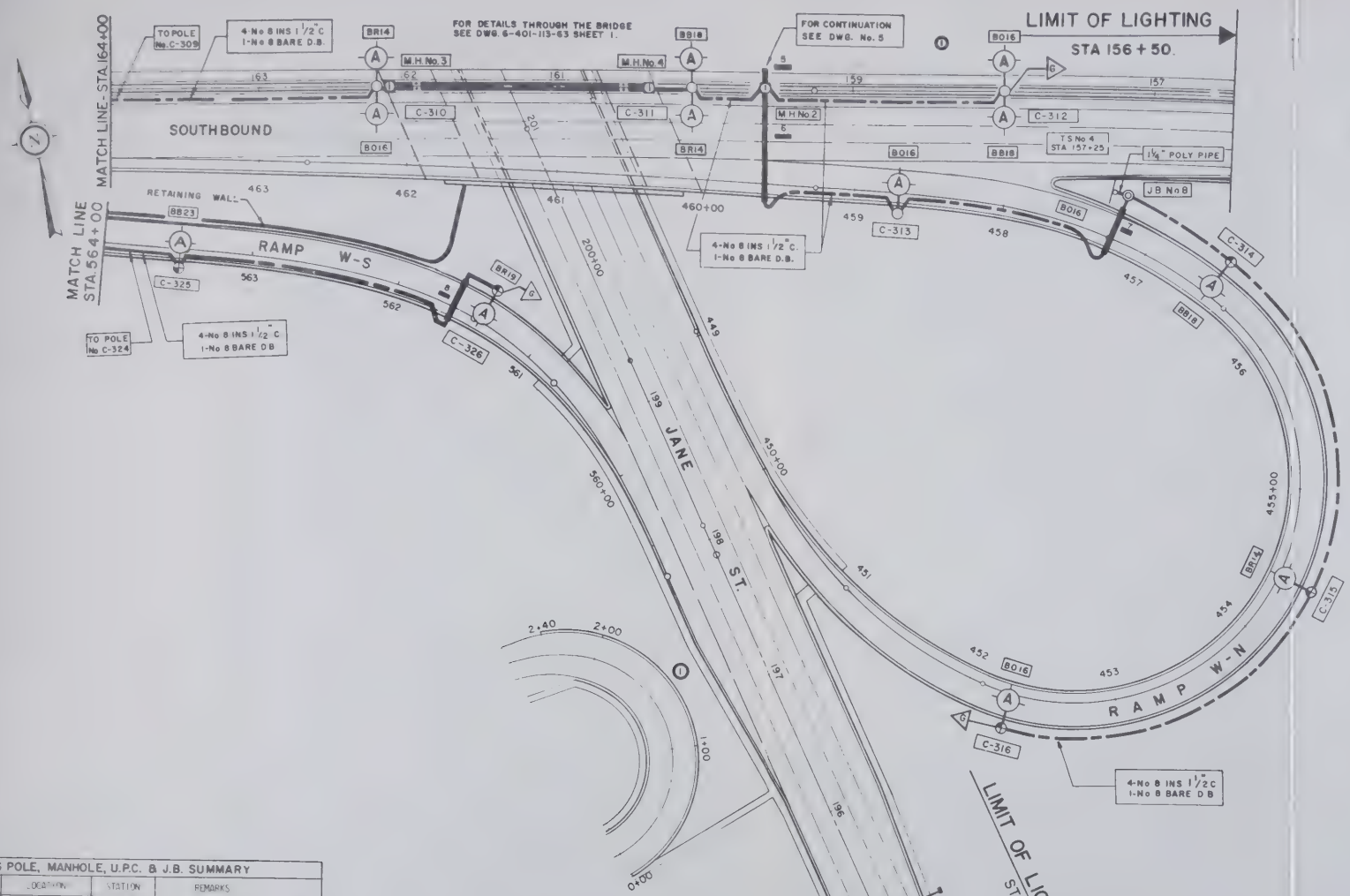
R	= RED.	LINE 1.	PHASE A.
O	= ORANGE.	LINE 2	PHASE B.
B	= BLACK.	LINE 3.	PHASE C.
N	= WHITE.	NEUTRAL.	NEUTRAL.
G	= GREEN INSULATED GROUND.		

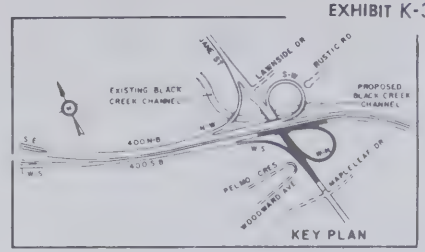
TYPICAL

CITY OF EDMONTON
SOUTH WEST BYPASS
STAGE 1

LIGHTING LEGEND

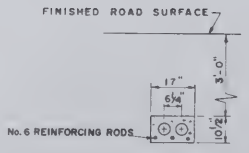
EXHIBIT K-32





TYPICAL

LIGHTING POLE, MANHOLE, U.P.C. & J.B. SUMMARY			
POLE NO	LOCATION	STATION	REMARKS
C-310	HWY 200 MED.	158+25	
C-311	HWY 200 MED.	160+10	
C-312	HWY 200 MED.	158+00	GROUND ROD
C-313	RAMP W-N	458+70	
C-314	RAMP W-N	456+50	
C-315	RAMP W-N	454+00	
C-316	RAMP W-N	452+30	GROUND ROD
C-325	RAMP W-S	561+50	
C-326	RAMP W-S	561+00	GROUND ROD
MANHOLE NO			
2	HWY 200 MED.	159+60	SPLICE CHAMBER
3	HWY 200 MED.	160+10	
4	HWY 200 MED.	160+35	
U.P.C. NO			
6	HWY 200 S.B.	159+60	2-4" DIA ASBESTOS CEMENT CONDUIT
7	RAMP W-N	457+25	2-4" DIA ASBESTOS CEMENT CONDUIT
8	RAMP W-S	561+60	2-4" DIA ASBESTOS CEMENT CONDUIT
J.B. NO			
8	RAMP W-N	457+25	



U.P.C. No. 6,788.

TYPICAL DUCT SECTIONS FOR UNDER PAVEMENT CROSSINGS

SCALE

1/2" = 1'-0"

SCALE

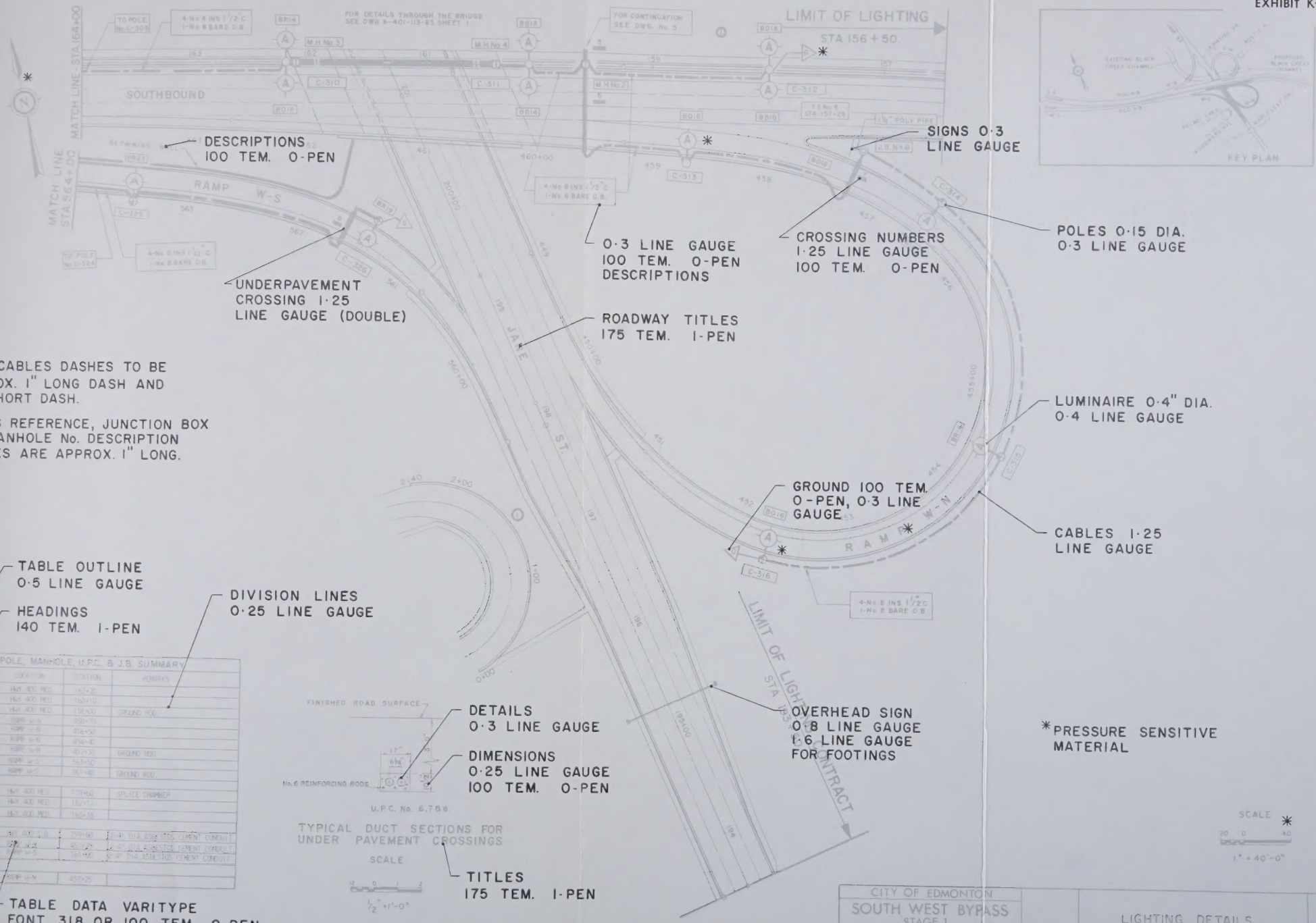
20 0 40

1" = 40'-0"

CITY OF EDMONTON
SOUTH WEST BYPASS
STAGE 1

LIGHTING DETAILS

EXHIBIT K-33


LIMIT OF LIGHTING
STA 156+50
SOUTHBOUND
MATCH LINE STA 164+00
MATCH LINE STA 56+00
RAMP W-S
RAMP W-N
JAE
198 ST.
LIMIT OF LIGHTING STA 193+00 CONTRACT
DESCRIPTIONS 100 TEM. 0-PEN
SIGNS 0·3 LINE GAUGE
0·3 LINE GAUGE 100 TEM. 0-PEN DESCRIPTIONS
CROSSING NUMBERS 1·25 LINE GAUGE 100 TEM. 0-PEN
POLES 0·15 DIA. 0·3 LINE GAUGE
UNDERPAVEMENT CROSSING 1·25 LINE GAUGE (DOUBLE)
ROADWAY TITLES 175 TEM. 1-PEN
LUMINAIRE 0·4" DIA. 0·4 LINE GAUGE
GROUND 100 TEM. 0-PEN, 0·3 LINE GAUGE
CABLES 1·25 LINE GAUGE
KEY PLAN

NOTE: CABLES DASHES TO BE APPROX. 1" LONG DASH AND ·2" SHORT DASH.

CROSS REFERENCE, JUNCTION BOX OR MANHOLE No. DESCRIPTION BLOCKS ARE APPROX. 1" LONG.

TABLE OUTLINE 0·5 LINE GAUGE

HEADINGS 140 TEM. 1-PEN

DIVISION LINES 0·25 LINE GAUGE

LIGHTING POLE, MANHOLE, U.P.C. & J.B. SUMMARY

POLE NO.	LOCATION	STATION	REMARKS
C-310	HWY. 400 MED.	162+30	
C-311	HWY. 400 MED.	160+10	
C-312	HWY. 400 MED.	158+50	GROUND ROD
C-313	RAMP W-N	456+70	
C-314	RAMP W-N	456+52	
C-315	RAMP W-N	454+80	
C-316	RAMP W-N	452+30	GROUND ROD
C-325	RAMP W-S	563+50	
C-326	RAMP W-S	561+80	GROUND ROD
MANHOLE NO.			
2	HWY. 400 MED.	159+60	SPLICE CHAMBER
3	HWY. 400 MED.	161+10	
6	HWY. 400 MED.	160+30	
U.P.C. NO.			
4	HWY. 400 S.B.	159+90	2-4" DIA. ASBESTOS CEMENT CONDUIT
7	HWY. 400 S.B.	161+40	2-4" DIA. ASBESTOS CEMENT CONDUIT
8	HWY. 400 S.B.	160+00	2-4" DIA. ASBESTOS CEMENT CONDUIT
J.B. NO.			
2	RAMP W-N	457+25	

TABLE DATA VARITYPE FONT 318 OR 100 TEM. 0-PEN

DETAILS 0·3 LINE GAUGE

DIMENSIONS 0·25 LINE GAUGE 100 TEM. 0-PEN

TYPICAL DUCT SECTIONS FOR UNDER PAVEMENT CROSSINGS

SCALE

TITLES 175 TEM. 1-PEN

OVERHEAD SIGN 0·8 LINE GAUGE 1·6 LINE GAUGE FOR FOOTINGS

*PRESSURE SENSITIVE MATERIAL

SCALE

1" = 40'-0"

CITY OF EDMONTON	
SOUTH WEST BYPASS STAGE 1	LIGHTING DETAILS